GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

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NOTE.

It was intended that this Report should have been published as Part H. of the Annual Report, Vol. II, 1886; but the illustrations not being ready, it was postponed and will now constitute part H. of the Annual Report, Vol. III, 1887. Additional developments on some of the mines to which it refers are noticed in Part S. same Vol.

Unless otherwise noted, the bearings throughout this Report are referred to the magnetic meridian.

TO A. R. C. SELWYN, ESQ., C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I send you herewith Part I of my report on Mines and Mining on Lake Superior, prepared in compliance with your instructions.

This part, whilst referring to the history of the whole region for the past forty years, and the economic and other conditions which have affected its development during that period, treats more particularly of the Silver Mining there, the subjects dealt with constituting the great bulk of the matter to be considered. In view of the fresh importance which the subject of Silver Mining in this region has assumed, owing to recent discoveries, it was deemed advisable to complete this part for publication at once rather than to delay it until the rest was ready.

Part II will treat of the mineral substances, other than Silver, found or mined in the region. These are receiving little or no attention at present, and, in comparison with what has been done in exploring and developing the Silver district, the history of the mining of these other substances constitutes a comparatively small part of the subject under consideration. This part is in an advanced state of preparation, but some important information is yet wanting to complete it, which I hope soon to be able to obtain when it will be at once put in shape for publication.

The field work of this investigation was only completed late in the fall of 1886, and the elaboration of the material thus obtained, together with the collection and preparation of the other information incorporated with it, has been, in the nature of the work, a very tedious and lengthy undertaking. The same applies also to the preparation of the illustrations, the data for which had often to be obtained from very various sources, and from people who had long since left the region; and all this, together with the natural difficulties encountered in compiling such data to form plans, etc., which should be as complete and reliable as possible, has caused the unavoidably slow progress of the work.

This work was further delayed owing to the fact that during the two winters following my appointment in July, 1885, to a position in connection with the work of the collection of Mineral Statistics, the greater part of my time was taken up in making, in conjunction with

Mr. Coste, the necessary preparatory arrangements for carrying out that undertaking; and in the compilation and writing of part of the report on that subject for 1887.

In conclusion, I beg to express my thanks to all those from whom I have received assistance during the progress of the field work, and to Messrs. S. J. Dawson, M. P., A. L. Russell, W. H. Furlonge, T. A. Keefer, P. McKellar, W. M. Courtis and H. K Wicksteed, who have supplied me by correspondence with much valuable information since leaving the district, and also to the many others who have kindly supplied information, maps, specimens, etc.

During the progress of this work I was assisted in the field by Messrs. A. W. Hopkins and J. H. Moore, in the summer of 1885, and by Messrs. H. P. Brumell and J. H. Moore, in the summer of 1886. In the preparation of the maps and illustrations for the report I was assisted in the office for a short time in the spring of 1886, and during part of the winter of 1886-7 by Mr. H. P. Brumell, and afterwards by Mr. J. White, who succeeded him in the spring of the latter year, and who did much towards the completion for publication of the accompanying map of the Silver Mountain district, and of the Sketch Map of the Thunder Bay mining region.

I have the honor to be,

Sir,

Your obedient servant,

7th July, 1888. ELFRIC DREW INGALL.

PREFACE.

The objects chiefly kept in view in the prosecution of this work have been: 1st. To make as complete a history as possible of the mining developments of the whole region. 2. To ascertain either personally or from the most reliable sources the results of such developments. 3. To examine as many examples as possible of the veins and mineral deposits with a view to the collection of information which might lead to their classification and a better understanding of their nature and relationships, and of the conditions under which they are found. Objects of investigation.

Regarding the attainment of the first two objects much difficulty has of course been encountered. The greater number of the mineral locations prospected have been worked upon by small gangs of men for periods varying from a few weeks to a few months, and that mostly years ago, so that those from whom detailed information might be obtained are now spread far and wide. Even where this is not so, those interested in the matter could hardly be expected to judge of results quite dispassionately, and again, where personal inspections of old mines were made, these being of course full of water, it was found necessary to supplement these observations, which were necessarily confined to the surface, by information obtained from others regarding the underground workings. In these cases however, a careful examination of the surface indications has resulted in useful and necessary additions to the information gleaned from such sources. Concerning the third object mentioned, I hope that the details and facts recorded in this Report may be considered desirable additions to our knowledge in this respect. Where advisable, I have also incorporated information gathered and published by other observers both amongst and outside of the officers of the Survey, with a view to making as complete a summary as possible of the evidence on the subject. Since the commencement of this investigation, after tedious enquiry, communication has been established with various people formerly connected officially with some of the important mining efforts of the past, and the information so obtained has been very valuable and will add materially to our stock of experience of the district.

Various questions naturally present themselves to capitalists, engi-

neers and others purposing to interest themselves in this region, such as the following:—

To what extent has this region been examined and prospected, and what have been the results of such search for minerals?

What is the state of the mining industry there at present, and what has been done in the past?

What have been the results of all these trials, and what experience has thus been gained of the nature and habits of the mineral deposits of the region?

How does the experience so gained apply to the recently discovered mining sections to which attention is at present directed?

In attempting to answer these questions, I have in the first part of the Report given the particulars of the work done, nature of the deposit and of its geological environment, etc., for each property which has been worked or prospected to any extent, and have thus summarised the evidence upon which are founded the general conclusions contained in the latter part.

Wherever it has been possible to secure the information for their compilation, plans, etc., illustrating the individual properties have been given, it being believed that a map or plan, even if somewhat diagrammatic, will produce a clearer idea in the mind of the reader than many pages of letter-press. A Sketch Map of the Thunder Bay region accompanies the Report which having been compiled from various sources does not pretend to represent the topography with absolute accuracy, but is as correct as the material at present available will permit, and is sufficiently so for the purposes for which it is intended, viz.: To show the various districts, their position, communications, etc., as well as the grouping and relationships of the veins as far as at present known. The rest of the illustrations being explained in their proper connection need no comment here.

Sketch map.

Every possible means has been taken to fill up gaps in our information on the subject in hand from reliable sources and doubtless a continuance of the effort would from time to time bring to light much that would serve to render this record still more complete, but the collection of such items being a very tedious process, it would be obviously unwise to further delay publication on that account. With the original matter then of this Report much extraneous and scattered information has been incorporated and rendered available, and it is hoped that in this way the Report here presented will be found to be as complete and systematic a record as it is now possible to obtain of Mines and Mining on the Canadian shores of Lake Superior, and the connected districts from the commencement of mining there in 1846 to the present day.

REPORT

ON

MINES AND MINING

ON

LAKE SUPERIOR.

PART I.

A. HISTORY AND GENERAL CONDITIONS OF THE REGION

The area which may be said to naturally come under study in the consideration of the above subject is very great, extending as it does through a tract comprised within 10 degrees of longitude and 3 degrees of latitude. To those unacquainted with the region and unaccustomed to deal with the great distances of a new country, it may convey a better idea of the size of this tract when it is pointed out that its area nearly equals that of England. **Extent of area dealt with.**

I have placed this rather extended meaning on the term "Mining Region of Lake Superior" as I feel assured that in course of time, as the country back from the Lake shore gets opened up, new mining districts will be discovered which will naturally connect themselves with this region. I have also included a large section of country to the North of Lake Huron which geologically, geographically, historically and otherwise, seems to be naturally connected with the East end of Lake Superior, and in which the mining developments will be a guide for the future in the whole region. Thus considered then, the area dealt with may be described as a belt of country extending along the north shores of Lakes Huron and Superior to an indefinite distance back from them, commencing about at longitude 81 degrees on the east, and continuing west to where the International boundary is intersected by longitude 91 degrees, thus including the silver bearing area extending south-west from and tributary to the town of Port Arthur.

This great region, until a comparatively recent period, was a *terra incognita* to the great proportion of even the inhabitants of the Canadian Provinces themselves, and to the present date, large sections of the area spoken of are only known to the trapper, the Indian and the timber hunter, and have not even come under much notice from the mineral explorer.

Speaking generally of the whole region, it consists for the greater

part of a great rocky area covered with bush, which is mostly very dense, whilst extensive swampy areas are frequent. In places, considerable stretches are covered with useful timber such as maple and pine, but for the greater part the bush is useless, except for local demand such as would arise from mining operations. Districts of considerable extent of good farming land exist at places, but a large proportion of this region is little blessed with soil, and seems only fitted to be the happy hunting ground of the trapper and mineral explorer. For these it has many advantages, as it is a land of rocky hills and mountains, of numerous lakes and rivers where the large extent of rock exposed gives a chance to find valuable mineral deposits, and where the water stretches, whilst being seldom navigable for larger craft, yet furnish canoe routes whereby the interior of the country may be reached.

Surface features of region.

Geological features of region:

As might be expected in so extensive a tract of country, the geological features present considerable diversity, although, apart from the superficial deposits, the rocks are all referable to the Palæozoic and Archean. It may be said to consist of a large area of Laurentian gneissic and granitic rocks, etc., within which are found numerous and considerable areas of plutonic and volcanic rocks, and of metamorphic slates, etc., which are considered to be of Huronian age, whilst overlying these, chiefly round Thunder Bay and Lake Neepigon, occur the sedimentary and volcanic rocks of the Animikie, Neepigon and Keweenian groups, whose approximately horizontal position and low angles of dip contrast markedly with the steeply inclined or almost vertical older rocks. The lithological and other details concerning these different groups of rocks are best left for description in connection with the various mining districts dealt with hereafter, and full descriptions of these particulars will be found in the various publications of our Survey.

Mineral resources of region.

Within these rocks are found veins and deposits carrying ores of iron, chiefly as magnetite and hematite; of copper, which occurs both in the sulphuretted and native state; of silver, in the argentiferous galena and some of the copper ores and also native and as sulphide; of gold, both free and in the baser form contained in pyritous and arsenical ores. Besides these there have been found deposits of zinc-blende, veins carrying molybdenite and minerals of nickel, the latter found in connection with native copper ores, not to mention other useful but less generally important minerals which have been occasionally found. Amongst the other useful products of the region, other than ores proper, may be mentioned quartz-amethysts, and agates amongst the ornamental stones; various structural materials, especially a fine

variety of red sandstone, amongst the mineral pigments, barytes which has been obtained from the native silver veins constituting part of their gangue. Plumbago has also been found.

Thus we have the following useful elements represented in the mineral deposits of this region: gold, silver, copper, iron, lead, zinc, molybdenum, nickel, arsenic and sulphur. Reports were spread recently of the finding of ores of mercury, but these lack confirmation.

History of the Region.

The history of the Canadian shores of Lakes Superior and Huron as a mining region may be said to have commenced about forty years ago, in 1846, when the first mineral locations were taken up. It is divisible into three periods separated by periods of inactivity, the first commencing as mentioned in 1846, the second in 1863, and the third in 1882, with the discovery of rich ore at Rabbit Mountain. Commencement of mining.

Attention was first directed to this region by the discoveries which were being made and had been made for some years previously in the copper bearing rocks of the south shore of Lake Superior. Reference was made to this by Mr. Logan (afterwards Sir William) in his "Report of Progress of the Geological Survey for 1843," as follows:— Attention first directed to search for copper

"It is at the summit of the rocks under description" (the inferior rocks) "in the peninsula lying between Lake Superior and Lake Michigan, in a great range of trap interposed between the transition series and a metamorphic group which rests on the granite, that Mr Douglas Houghton, the State geologist of Michigan, has made the discovery of an important collection of copper ore veins which are likely to become of considerable economic value, and it remains to be ascertained whether an analogous condition of circumstances may not extend to Canada."

Following this we have a Report addressed by Mr. Logan to the "Committee of the Honorable the Executive Council" dated the 24th March, 1846, in which, in answer to enquiries made by them respecting the mineral region of Lake Superior, he deals with "the data upon which it would be judicious to proceed in ascertaining the value of the mineral district in question; and the principles which should be taken into consideration in dividing it into lots for the purpose of mining locations."

The Government having decided to act upon these suggestions gave Mr Logan instructions to investigate this region, which work he started in May, 1846, and spent the whole of that summer voyaging round the Canadian shores of Lake Superior. Mr. Logan's exploration of the Canadian shore of Lake Superior in 1846.

In this voyage he was accompanied by a properly authorized land

surveyor who determined the position and limits of numerous tracts of mineral land which were required by sundry capitalists who had applied for them. These grants of land, to the number of 27, comprised about ten square miles each, having a width of about two miles, and running back from the coast about five, and were granted by the Government evidently upon the supposition that *bona fide* work on them was intended, and that the country would thus get the benefit of the tests there made of the value of the mineral deposits of the region.

First mineral locations granted.

Precautions suggested in granting mineral lands.

Mr. Logan, in his Report, urged that in order "to secure a *bona fide* intention of working the minerals and to avoid the encouragement of mere stock-jobbing speculation,—there should be some stipulation on the part of the Government, that a certain number of miners should be employed on each location" He further on points out that "In such sales of locations, it must be recollected, that all control over the working and proving of the mines would be relinquished by the Government, and the private interests of parties might in some cases carry them no farther than the establishment of a company for the purpose of traffic in shares; whilst in others, persons of a less sanguine temperament than their neighbours, might patiently wait to observe the success or failure of the more adventurous."

Effect of neglect of precautions.

It will thus be seen that even at this early date the Geological Survey had pointed out the precautionary policy necessary to be observed by the Government in order to ensure the proper development of the mineral resources of the country, and it is curious and instructive to observe that notwithstanding the clearness with which this time-honored experience of the development of mining districts was pointed out, the opposite policy of losing all control over the development of this most important part of the resources of the country has been followed ever since with the consequent effect of seriously retarding the opening up of the region.

Continuation of history.

But to proceed with its history. In this same year the *Bruce Mines* copper ore veins were discovered on the north shore of Lake Huron, east of Sault Ste. Marie, besides some other discoveries in that section of less importance of similar veins.

Discovery, &c., of copper ore veins of Lake Huron.

The development of the *Bruce Mines* veins was carried on by the *Montreal Mining Company* from this date until they were taken in hand by the *West Canada Mining Company* of London, England, which had commenced working similar veins in its immediate vicinity in 1855 under the name of the *Wellington Copper Mine Company*. From this time on, this Company continued to operate all this group of mines until about 1875, when work was discontinued, chiefly owing to the price of copper having for some years previously been so low as to

leave no margin of profit on the working of the mines. The operation of these mines has been the most extensive, and successful mining venture of the whole region here dealt with, continuing as they did over a period of more than thirty years, and for the greater part of that period yielding handsome profits. They employed directly and indirectly a large number of people, and were the cause of directing considerable attention to the district, and of forming quite a settlement around, and to this day a large proportion of the present inhabitants now engaged in farming, etc., are old *Bruce Mines* employees, or their descendants. So much then for the indirect benefits accruing to a district from the development of its mineral resources.

Period of stagnation in western district of L. Superior.

For sixteen years following Mr. Logan's visit to the region and the acquirement of the before mentioned mineral locations, little attention was paid to the mineral resources of the western end of the Lake, beyond a few spasmodic efforts at exploration and testing of some of the silver properties of the Thunder Bay district, for a year or two after their acquirement in 1845-6.

Spasmodic exploration of eastern district

From time to time, however, the more easterly portion of the region received a little attention. The search for copper seems to have first occupied attention, and discoveries were made at intervals, of veins carrying sulphuretted copper ores, more especially in the Huronian rocks of the Lake Huron district, and a few in connection with Huronian and Laurentian rocks on Lake Superior. Amongst these were the *Wallace* and *Emerald Mines*, and some other places on Lake Huron and the discoveries at the *Begley*, *Palmer*, and *Point aux Mines* properties on Lake Superior, at which latter place work was carried on in 1856.

Exploration and testing of native copper formation.

The continued success attending the exploration of the native copper-bearing rocks of the south shore, now called Keweenian series, directed attention to similar areas on the north shore, and from time to time, during the period under consideration, slight efforts were made to discover the native copper deposits of this formation. The exploration of the St. Ignace Island properties in 1846 came first, but a great deal does not seem to have been done there. Following this, in 1853 came the commencement of work on the east end of Michipicoten Island by the *Quebec and Lake Superior Mining Association* on the native copper-bearing beds there, and later, a little testing work was done on similar beds on the north shore of the same Island at a place known as the *Bonner Mine*, where some interesting nickel and silver minerals were associated with the copper. At Mamainse Point also, about this time, some work was done on native copper-bearing fissure veins in this formation on a location known as the Meredith location belonging to the *Montreal Mining Company*. At none of these places, however, were the developments very extensive.

Second period of activity.

This brings us to the second period in the history of the region which began about 1863, when an era of much greater activity was inaugurated. This was more especially the case in the silver district of the western portion about Thunder Bay.

Further operations in the native copper formation from 1863 to the present.

The eastern end of the Lake did not benefit so much by this increase of interest in mining matters. Another effort was made in 1863, to place the *Quebec Mine* on Michipicoten Island on a working footing, and it was operated for about a year, after which this mine received no attention until 1881, when an English Co. acquired the property, and did considerable work, and with an interval of idleness during a change of ownership, this has been continued, and mining was still progressing at this spot in February, 1887. Another English company, the *Lake Superior Native Copper Co.*, in 1881 acquired the old McDonnell location at Mamainse from the *Quebec & Lake Superior Mining Association*, and expended some $400,000 in testing various veins which had been discovered there in 1880, and in erecting machinery, &c. The *Silver Islet Company* also about this time had a force at work, and did a considerable amount of exploring and testing, both on the old Meredith location, which is adjacent to the last mentioned, and had been worked as previously mentioned, and on the adjoining one to the south. Work was suspended, however, at all these places and, excepting at Michipicoten Island, nothing was being done in 1886.

Discoveries of iron ores.

Evidences of the possible future of the region in the direction of iron production first came to hand about 1863, in the discovery of hæmatite and magnetite deposits at various places along the shore of the Lake between Port Arthur and Sault Ste-Marie, but beyond an insignificant amount of testing work there is nothing to record, so that the possibilities of the region in this respect still remain an unsolved problem. This subject is, however, now beginning to occupy a good deal of attention, and fresh zest has been given to the search for ores of this metal in the Thunder Bay district by the great success attending the opening up of the deposits at Vermilion Lake in Minnesota, just across the International boundary in a W. S. W. direction from Port Arthur. It is argued, that as these are within a measurable distance of Canadian territory, and there is good reason to believe that the areas of similar rocks found a little way across the line in Canada are the continuation of the Vermilion Lake rocks, that there is therefore very good reason to predict the discovery of equally good and extensive iron ore deposits in our own territory. In fact, the veteran explorers of the district, the Messrs. McKellar Brothers have recently announced such a discovery in the Lake Shebandowan section.

The year 1870 saw the first discovery of gold-bearing ores at what is

now known as the *Huronian Mine* at Jackfish Lake, near Lake Shebandowan, about 70 miles in a direction a little N of W. from Port Arthur, where the precious metal occurs in the native state as well as combined in sylvanite and pyritous ores. From that day to the present, a few more gold-bearing veins have been discovered from time to time at various places both in the above mentioned district and on the shores of Lake Superior between Port Arthur and Sault Ste-Marie. The metal in all these is mostly carried by the sulphurets. The work done on these gold-bearing veins has not been great, considering the lapse of time since their discovery, and what has been accomplished in this way has been almost altogether on two of them, viz.: At the *Huronian Mine* which has been worked at intervals since its discovery with more or less vigour, but is now closed, and at the *Heron Bay Mine* which was discovered in 1872, and then worked for a short time, and also about two years later for a short period. Discovery and testing of gold veins.

In the Black Bay section of the Thunder Bay district, several lodes carrying galena were found in 1863 and 1865, which seems to have been the first time anybody turned their attention to this mineral. Amongst these are the *Cariboo* and *Enterprise* veins, at which latter place some test work was done in 1872, and in the same section similar work was in progress at the *Arctic Mine* in 1884. The only other localities of this mineral of any importance are at McKellar's Harbor on the north shore of Lake Superior near Middleton on the C. P. R., where an 80 feet shaft was sunk in 1878; and at the *Victoria* and *Cascade Mines* at Garden River near Sault Ste. Marie, at both of which latter places considerable underground work has been done and stamp mills have been erected. The work at the latter mine was prosecuted during the years 1880 to 1885, whilst the former worked during the greater part of this period, but had ceased operations in 1884. None of these galena veins were being worked at the end of 1886. Galena veins.

The history of the mineral development of the eastern end of the Lake would be incomplete without a reference to the *Zenith Mine*, about eight miles north of the mouth of Steel River on the north shore of Lake Superior about six miles east from Rossport on the C. P. R., where a deposit of zinc blende was found in 1884, and some test pits sunk on it. Zinc-blende discovered.

To complete this chronological review of the chief mining events of this region a few words must be said on the subject of the discovery of the silver veins proper of the Animikie rocks of the Thunder Bay division. History of discovery of silver veins.

Although a number of these veins had been located along the coast and islands S.W. from Fort William during the before-mentioned trip

First discoveries regarded rather as copper and lead veins.

of Mr. Logan in 1846, and although some pockets of rich silver ore were found in them, the only ones on which much test work was done, viz., those of *Spar Island* and the *Prince Mines*—seem to have been regarded more as copper than as silver veins, and it was not until 1866 that the first silver vein, or rather the first one properly recognized as such, was found. Veins had been located in 1863, in this formation at the *Wallbridge Mine* and at *Lot* 11 in Paipoonge township, and the former had had a shaft sunk upon it, but they also seem to have been looked upon as bearers of copper sulphurets and galena ores rather than as silver veins proper.

Subsequent discoveries of recognised silver veins.

Thus the discovery of the *Thunder Bay* vein in 1866 by Mr. Peter McKellar inaugurated the era of mining of the higher grade silver ores which has been continued with varying success up to the present. The next year, the *Shuniah* or *Duncan* vein was located, and in the summer of 1868 a Mr. Morgan, who was employed on the exploring party which, in charge of Mr. Thomas Macfarlane was examining the locations held by the *Montreal Mining Co.*, found rich silver ore in the now famous *Silver Islet* vein, which resulted in sixteen years of successful development of a mine which has been the great mining feature of this end of the Lake.

For the seven following years, exploration and development work was actively prosecuted in the district surrounding the *Thunder Bay Mine*, chiefly on the veins already mentioned, and at the *Beck* or *Silver Harbor*, 3 *A*, and *Cornish Mines*. Some discoveries were also made of veins along the W. coast of Thunder Bay, and on the Islands in that vicinity, and work done to test them, notably at *Pie*, *Jarvis'*, *Thompson's*, *McKellar's* and *Mink Islands*, and at *Stewart's Location* near Pigeon River, *Sturgeon Bay*, &c.

Intervening period of quiet in silver district.

By the year 1875, most of these enterprises had ceased working, and a period of quiet intervened, for though the *Shuniah Mine* did not finally cease operations until 1881, and the *Silver Islet* until the spring of 1884, the former had little success and the latter had passed the zenith of its prosperity.

Renewal of activity.

Following this period of quiescence came a renewal of activity which, commencing with the discovery of remarkably rich ores of silver at *Rabbit Mountain* in 1882, has been continued with increasing vigour until the present. Discoveries at numerous other places around this point have quickly followed, notably of the *Beaver*, *Porcupine*, *Silver Creek*, *Little Pig*, *Big Bear*, etc., veins, the first of which has of late become especially famous by reason of the recent find of large quantities of rich ore.

To this third period also belong the discoveries near Whitefish Lake,

to which district attention was first directed by the discovery of the *Silver Mountain* vein carrying rich silver ores. This discovery has been followed by the location of numerous veins in this formation both in its immediate vicinity and for some distance westward around Whitefish Lake.

Natural and Economic Conditions.

To fully judge of the results attained in this great region from the standpoint of the miner, attention must also be paid to the natural and economic conditions under which its development has taken place, and when it is remembered that the history of mining there dates back forty years or more, it must be admitted that when the matter is viewed superficially the results attained seem very small in view of the apparently numerous and widespread discoveries of minerals. A closer inspection however of the conditions existent during this period will go far to explain this seeming anamoly.

Lack of communications throughout region.

The communications of the region with the outer world have until recently been very poor. Until the opening of the Canadian Pacific Railway from Winnipeg to Port Arthur in 1883 and throughout in 1886, the only means of communication with other parts of the continent was by steamboat, and this necessarily during the summer only. Furthermore, it was only the two ends of the Lake that benefitted by this, Fort William and Port Arthur at one end, and Sault Ste. Marie at the other. A certain amount of communication was of course kept up between these points and isolated fishing stations around the coast by tug, but this only partially and occasionally met the requirements of prospectors. The coast line naturally formed the base of operations from which the exploration of the interior of the tract was undertaken, and this stretch of some 400 to 500 miles had to be reached from the two previously mentioned centres by very imperfect means of transit, exploratory parties generally having to make long expeditions in sail boats carrying with them all their material, camps and provisions for the whole season's work. Even when the desired section was reached, other difficulties would have to be confronted, owing to the absence of any roads, so that the interior could only be reached by canoe routes or by starting through the bush on foot when every thing needful had to be carried on men's backs. The limited amount it is thus possible to transport, and the slowness of such means of travel over a rugged country covered with dense bush naturally forced the explorers, who could not of course have a large gang of men packing

Communications by water at first.

in material after them from the centre of supplies, to limit themselves to the examination of the country in the immediate vicinity of the shores of the Lake. Those who are not acquainted with new countries may perhaps better realise these conditions by supposing all England covered with dense bush and uninhabitated and its exploration undertaken with the coast line as a base of operations by comparatively a handful of explorers, who would have to start either from London or Newcastle in canoes or small boats.

Water travel unavailable during winter.

Even this means of travel was prohibited during the six months winter, for the end of November sees the stoppage of all water communication on the Lakes, and apart from this, the advent of snow, of course, puts an end to exploring.

Early difficulties and expenses due to isolation of region.

Incidents which occurred during the working of the *West Canada Mining Company* at the *Bruce Mines* on Lake Huron well illustrate some of the difficulties consequent upon this state of things. Owing to the state of siege existent in the region from the absence of winter communications, a stock of all necessary material for the whole winter had to be taken in every fall. One fall, the steamer bringing in the horse feed was wrecked, and the management had to resort to the expedient of substituting flour, of which they had a good stock, and having built a baker's oven, fed the horses on bread all the winter. At another time, the general supply steamer having broken her propeller shaft, a message was with some difficulty sent to the merchants supplying the goods, who duplicated the order for the winter's supply and chartered another steamer, only to find that it was too late, and that it could not get through on account of ice, so that the supplies had to be collected from all over the district, and teamed from long distances at great expense.

Before the opening of the ship canal at Sault Ste. Marie, Michigan, between Lakes Huron and Superior in the spring of 1855, things were even worse, for there was then no means of passing the falls at this place, and everything had to be trans-shipped and portaged overland for about two miles, and taken up Lake Superior in large canoes or sail boats. It is said that when the *Montreal Mining Co.* started work at *Point aux Mines*, that bricks which they took up for their smelting furnace cost 25 cents a piece at the mine, and everything else in proportion.

All this of course rendered access to the region both difficult and expensive, and largely deterred people from efforts to make or develope discoveries.

Another source of difficulty and expense, especially in the earlier part of its history, has been the difficulty of procuring supplies in the

region itself, for owing to the absence of agricultural settlers until a comparatively recent period, everything had to be brought in from distant places thus incurring heavy freight charges.

Deterrent effect of dense bush.

The effect of the dense bush also, covering as it does so large a proportion of the country, has been very potent in retarding discovery, as every one who has ever travelled through it realises how effectually it limits the vision, so that one may travel quite close to indications of a mineral deposit and never see them. This same retarding effect is felt in trying to work out the extent of deposits found, and the relationships of various exposures of either rock or vein, and when it is remembered how even when actual soil is absent and the rock is near the surface, it is yet concealed by moss, fallen trees and the general debris of defunct vegetation, the difficulties due to these causes may be better realised. Once the veins or deposits have been located, however, and traced up, this same covering of bush is found very useful in supplying material for building and fuel.

Comparison of conditions of development of region with those of other mineral countries.

Some points of difference between the development of this region and that of others on the continent is worthy of notice. In the case of the famous California and Rocky Mountain districts of the United States, the discovery of placer gold caused a tremendous rush of explorers to these districts in the first place, from the fact that this class of deposit enabled individuals, or small parties of individuals, without much capital to work claims in their own interests, with the chance, if lucky, of making large sums of money in a short time. This influx was largely assisted by the system adopted of staking out and recording the claims, whereby a discoverer or locator could acquire his property with the least possible delay, in the simplest manner and at the smallest expense. Thus these districts suddenly received a large mining community, which led to the opening up of the country in every way so that when the placer diggings began to get worked out, the explorers, being already on the ground, were naturally led to turn their attention to the discovery of veins and other mineral deposits, whilst all the necessary communications being already in working order, the conditions were very favorable to the opening up of mines at once, when found, and the eyes of capitalists being already turned in that direction by the original gold excitement, it was found easier to interest them in the proposed enterprises.

The Lake Superior region has, however, had none of these benefits. There has been no preliminary inrush of thousands of explorers and the opening up of the region has been consequently, as mentioned, very gradual, whilst the process by which discoverers can secure their claims has not been very satisfactory.

Retarding effects of mining laws.

The present system offers every facility to the man of means to acquire and to hold for an indefinite period, large tracts of land around discoveries, but retards and renders it difficult for the explorer himself to acquire his discovery. The process acts somewhat in the following manner. An explorer makes a discovery and possibly secures it but within a few months or even weeks, all the land for several miles around will have been surveyed and tied up by parties whose means allow them to hold for an indefinite period whilst they have not the funds or do not care to meet the much larger expenditure required to develop their properties. The interest of this class is to hold with a view to re-selling at much enhanced figures when the developments on the first good finds cause a demand for mining locations in the section. This does not always come about according to the expectation of the investors, so that at present large tracts of land in the mineral regions are tied up and held thus, the amount of taxes * on them being a comparative trifle to such as have spare funds enough to go into this kind of speculation whilst it is quite a considerable item to the prospector whose means, already slight, are all required to outfit him for the search.

Large areas tied up for speculative purposes.

The extent to which this state of things exists in one part of the region will be rendered plain by looking at the appended Sketch Map of Thunder Bay region, where the areas of patented land are shown, of which one may safely take four-fifths to three-quarters to represent mineral lands ties up. The worst effect of this system is that it disheartens the actual explorer and keeps him out of the district, for instead of a promising discovery causing as it should a rush of actual explorers to the section and a consequent multiplication of discoveries, the land around the very spot where other finds might be expected, is speedily bought up and discoveries made on property belonging to others are not very profitable.

This subject is of course a complicated one, but after studying the matter in the district and making enquiries amongst actual explorers, one cannot help coming to the conclusion that the effect of the mining laws is to encourage a wholesale speculative acquirement of mineral lands on the slightest provocation, rather than to ensure actual working and to foster discovery by rendering it as easy as possible for the explorer to get the full benefit of his toilsome and dangerous efforts.

Attention drawn to this in the past by Geological Survey.

Attention was drawn to this matter from time to time by the Geological Survey, for beside the already quoted suggestion of Sir William Logan in 1846 and other places, Mr. Macfarlane refers to it in his Re-

* A tax of 2 cents per acre on all patented lands in Algoma was imposed in 1868.

port on Lake Superior published in the Report of Progress of the Survey for 1866, page 147, where he says. "Although important results might reasonably be anticipated to flow from a search for rocks having the lithological character of the cupriferous beds or with the compass in the manner above indicated, probably the best method would be to make such arrangements as would induce the experienced miners and explorers of the south shore to undertake the search. So far as I can judge, numbers of them would be very willing to do so were they only certain that after having made a discovery they could reap the advantages. At present the impression prevails amongst them (how far it is justified I am unable to say) that in the event of their discovering valuable minerals and applying for the land containing them, it would, before it would be surveyed and secured, find its way into the hands of some more favored individual. In order to prevent this, it would be necessary, after ascertaining the limits of the copper bearing rocks or of the 'mineral range,' as it is called, on the south shore, to have those parts of it which are still unsold, surveyed, laid out in not too large lots; establishing a price for them such as that at present fixed, and making arrangements by which the public would at once know what lots were unsold, and by which any applicant for one of those could at once secure it."

Change of laws necessary to encourage exploration.

Were a system adopted based on the general principle of the discoverer or other person, holding his claim by doing a certain yearly amount of development work on it, coupled with arrangements whereby he would be allowed to make a preliminary definition of its position and area on the ground at the time of discovery, and were steps taken to make this widely known, it would undoubtedly greatly assist in inducing more explorers to make this region the scene of their operations. This is an end very necessary to attain, for although many efficient explorers have given attention to the region, still in proportion to its extent, their number has been ridiculously small, and it speaks well for the general prevalence of mineral that they have found so much as they have.

These proposed ameliorations of the conditions under which the prospector has to work are rendered the more necessary just now in view of the extensive new sections of country recently thrown open for exploration by the completion of the C. P. Ry. and its branches within the region in which the tying up of the land has not yet taken place.

Even when work has been commenced with a view to test deposits found, failure has often been courted, owing to the limited ideas held, of the extent of the expenditure and work necessary to convert an un-

Bad effects of erroneous ideas of mining requirements.

proved prospect into a proved mine, which misconception has caused premature abandonment of the effort, or a start to be made with insufficient capital, so that the end of the funds at disposal has been reached before the question is satisfactorily answered as to whether or not the mineral existed in paying quantities. Added to all this, a failure on the part of operators to realise to what extent a mine should be tested before erecting large stamp mills and making other surface expenditures not immediately called for, has often caused a waste of much capital, which used on actual underground work, might have seen the venture through barren stretches of vein to a successful demonstration of its value.

These failures, when from such causes, give the region an undeservedly bad name, and render it difficult to interest capitalists who living far distant from the section and unacquainted with the facts, must necessarily judge from superficial appearances.

Of the multitudinous erroneous ideas which find currency amongst explorers and others working in such a region, and of the large loss of energy, etc., in ill-directed effort consequent thereon, one need hardly say more, other than that when they have found common acceptance, they have materially affected the direction of the developmental energy in the district. One case, however, may be given as an illustration where an explorer acting on a belief widely accepted by the prospectors that " true fissures always run straight ", had run a picket line of about a mile in length through the bush from a short outcropping of a vein, and then with perfect faith had sunk a shaft close to a creek bed and at a place where the thickness of the clay covering was evidently at least fifty feet, and probably much more, so that his chance of finding solid rock, even at a reasonable depth was small enough, not to mention the other absurdities of such a proceeding.

In pursuing the consideration of the subject of this Report viz.—Mines & Mining in the Lake Superior Region—the matter presented will be considered under the headings of the various mineral substances there found.

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B. SILVER MINING.

Under this head will be considered the Silver mining proper, as distinguished from the operation of those veins carrying argentiferous lead or copper ores, and its history is practically that of the western end of the region, i.e., of the Thunder Bay mining district, for whilst veins and deposits have been there found and operated to a slight extent carrying other ores than the silver ores proper of the district, yet they have been so far comparatively few in proportion to the others, and will be considered under their proper heading in Part. II.

Extent of silver district.

This district, which is comprised within the area covered by the appended Sketch Map, has been more actively prospected than any other section of the region herein dealt with. Its history has already been given in a general way. The name of Mr. John McIntyre, the officer who was in charge of the Hudson's Bay Co.'s post during the earlier part of the history of the region, is prominently connected with the mining efforts of that time in association with the Messrs. McKellar Brothers whose active explorations extending over many years have done so much to prove the widespread existence of mineral deposits in the district.

Early conditions.

The old Hudson's Bay Co's distributing and trading post of Fort William at the mouth of the Kaministiquia river naturally became the headquarters of the first mineral explorers, and remained so till the commencement of the operations for the construction of the Dawson route to the North-West. This road came out at a point on the shores of the Bay some three miles from the old Fort causing the village of Prince Arthur's Landing to grow up which has subsequently developed into the present town of Port Arthur, so that the two places with their wharves, &c., form the head of navigation of the great Lakes for the Dominion, and have become the headquarters of much mining activity at present.

Recent improvements in accessibility of district.

The means of communication of this district have been much improved of late, and are now very good. The completion of the C. P. Ry. affords connections with the rest of the continent, whilst still cheaper freight rates will be obtainable in summer from the numerous steamboat lines, by which the products of the mines can be shipped direct to other ports in Canada, or to American ports on the lakes. Starting from Port Arthur as a centre, the shore portions of the district can be easily reached by small craft or tug, whilst the C. P. Ry., Dawson road and numerous canoe routes over the lakes and rivers give means of communication with the inland portion.

Geological features.

The rocks of the district are comprised within several areas which are marked as Huronian, Laurentian and Lower Cambrian on the published maps of the Survey, and also include several granitic masses.

The veins carrying the ores of silver occur with one or two exceptions, which are pointed out later on, in the lower division of these lower Cambrian rocks which is known as the Animikie series, and whose distribution and extent are shown upon the appended Sketch Map. The chief area is that extending S. W. from Port Arthur which is roughly triangular in shape, with sides of about 40 miles extending along the west shore of Thunder Bay, 60 miles along the International boundary at Pigeon River, and 80 miles along the northern side, where the formation abuts against the Archæan rocks, which gives an area of approximately 1,200 sq. miles. Besides this, there are other areas of these rocks as shown on the map, on the N. E. side of Thunder Bay and extending down its eastern coast to Silver Islet. With the exception however, of this latter mine, all the discoveries of importance are confined to the first mentioned area, the general features of which it would be well to describe before going on to the detailed description of its mining phenomena.

Extent and distribution of silver formation.

Surface characteristics of silver area.

The surface of the region presents a number of flat-topped hills and ridges, the former frequently roughly circular in shape, separated by valleys about two or three hundred feet deep. From the tops of the hills down, the rock is shown in cliffs varying in height from 30 to 150 feet, below which the debris fallen from above slopes off at an angle of about 45° for probably another 50 feet, when it merges into the gentler slope of the clay and soil filling the valleys. The peculiarities of the landscape due to these table-topped hills is shown on the accompanying panoramic Hill Sketch, which also shows the very different profile of the surface of the Archean rocks to the N. as contrasted with the Animikie hills to the S., the division between the two being about in the position of the letter " A ". The little flat-topped hills, " B. and C ", in the distance are most probably outliers of the Animikie formation lying on the Archean rocks. The mineral discoveries are so far mostly confined to a belt of country running along the northern fringe of the formation between Arrow lake and Port Arthur, and to the coast and islands of the N. and W. sides and in the mouth of Thunder Bay, the country in the interior of the triangle being comparatively little known. A few discoveries of similar veins have been made in the eastern areas of these Animikie rocks, but besides the notable one of Silver Islet, little or no work has been done upon them.

Distribution of mineral discoveries.

The valley bottoms in this area have usually a considerable depth of soil, consisting often of a compact white or yellow clay with varying

thicknesses of alluvium on top. The bush which covers the whole district consists mostly of poplar and birch, in the lower lands with some intermixed pine, etc., whilst balsam, spruce and tamarac preponderate in the swampy parts. The trappean capping of the tops of the hills is usually scantily covered with soil, and generally supports a growth of jack pine, the dark foliage of which causes them to stand out prominently against the lighter shades of bush in the valleys. These valleys, forming as they do a considerable proportion of the area of the country and containing good soil, for the most part, render this section important from an agricultural as well as from a mineral standpoint.

Character of bush.

Agricultural possibilities.

In connection with the subject of the surface it will be interesting to note the frequent occurrence of smooth surfaces of rock which have been polished and grooved by ice, these show chiefly on the shores of Lake Superior and the inland lakes and rivers.

Glaciation.

It may be well here to give a short description of the general features of the Animikie rocks, leaving the details for consideration later on in connection with the description of the Silver Mountain and Coast groups where they were most carefully studied. Their relationships to the other formations of the district are to be seen on reference to the Sketch Map on which the boundary lines of each are given. These lines were put on from information gleaned from various sources, those west of Port Arthur being located from work done by myself, and from information kindly given by Dr. A. C. Lawson, whilst east of the same point, their position has been defined by the investigations of Dr. R. Bell and from data supplied by Mr. Peter McKellar of Fort William.

Geological character and relationships of Animikie series

The formation lies nearly horizontal, and rests in this position on the denudation surfaces of the older rocks which shew to the north whilst in their southerly and easterly extension near Black Bay, and in Thunder Cape peninsula, they are covered up by the rocks of the Neepigon formation, and S. of this, at the island in the mouth of Grand Portage Bay, are seen to pass under the Keweenian series, which consists of interstratified beds of conglomerate, sandstone and various trappean rocks. The rocks comprising this silver bearing formation consist of basic traps, black and grey argillites, cherts and jaspers, with some ferruginous dolomites, the mineralogical composition and structure of all of which will be understood by reference to the Appendix which contains the notes of Mr. W. S. Bayley of Johns Hopkins University, Baltimore, on his microscopic examination of typical specimens of these rocks collected by myself.

This Animikie formation is divisible into an upper and lower portion which while being quite distinct are not separated from each other

Sub-divisions of the Animikie.

by any very definable line, the rocks of each division at places taking on somewhat of the nature of those belonging to the other. Thus the chief character of the lower division consists in the almost entire preponderance of siliceous rocks, such as chert and jasper, which are often accompanied by ferruginous dolomites, and themselves all contain more or less iron in the oxidised state, at some places carrying so much magnetite as to constitute almost an iron ore. An analysis of such a piece, by Mr. Hoffmann, gave 53 per cent of iron, titanic acid being absent.* Occasional developments of the black argillites are found interstratified with the silicious beds but they are only local and do not seem to be ever of any extent.

Lower division.

Upper division.

In contrast with these, the upper division is formed for the most part of the black, soft, carbonaceous argillites. These are occasionally dolomitic, and at some places are quite ferruginous, whilst at others they hold such a large percentage of silica as to approach very nearly in character to the rocks of the lower division.

Distribution of lower division beds.

The cherty and jaspery rocks coming in at the bottom of the formation show chiefly in a strip forming its northern fringe where it abuts on the Archean. They constitute all the lower lying land north of the range of hills which extends along the southern boundary of the valleys of the Whitefish and lower part of the Kaministiquia rivers, commencing at McKay's Mountain on the east, and passing through Rabbit and Silver Mountains, and westward from this. These cherty rocks would seem also to constitute the greater part of the extension of the main area east from Port Arthur, and of the fringe of this formation along the North shore of Thunder Bay as far as the Mackenzie river, this section containing most of the Port Arthur group of veins.

Outliers of lower division beds.

Outliers of these rocks are to be seen as detached flat-topped hills out on the Archean area, some distance removed from the northern edge of the Animikie. The Outpost Hills shown on the Sketch Map constitute a group of these† which, when visited, were found to consist of high bosses of granitic and gneissic rocks, on the top of which rest thin sheets measuring from 20 to 30 feet thick of the typical cherty rocks of the lower division, with a capping of about 100 feet of the usual dark, vertically columnar basic trap. The opposite view entitled, owing to a printer's error, "Outline instead of Outliers of the Animikie on the Archean" shows the distinctive shape of these hills, their peculiar contour enabling one to recognise several other evidently similar outliers which show to the east of those shewn.

In passing south across the strike of the formation, one comes to the

* Report of Geol. Surv. 1866. Part I, Analysis of Iron Ores No. 4. Idem, 1887, Analysis No 10.

† By mistake the Archean ruled tinting on the Sketch Map has been run right over these outliers, which should, of course, have been left blank.

E. D. Ingall, Photo. 1886. Ives-Process. G. E. Desbarats & Son, Montreal.

OUTLINE OF THE ANIMIKIE SERIES, NORTH OF WHITEFISH RIVER
ONTARIO

E. D. Ingall, Photo. 1886. Ives-Process. G. E. Desbarats & Son, Montreal.

TRAP FLOW ON ARGILLITES, ANIMIKIE SERIES
SILVER MOUNTAIN DISTRICT.

beds of the upper argillaceous division in the higher levels and forming the range of hills just mentioned, where they show in the cliffs which usually form their boundaries, and are seen to underlie the trap-sheet usually constituting the capping or top of these hills and ridges about which it is noticeable that they very frequently have a distinct southerly dip, their north facing aspect usually constituting steep bluffs and cliffs. These upper division beds would seem to form the surface rocks in all the area lying south of this fringe of hills, as far as can be judged from the reports of persons who have traversed it, and from the study of the cross section of the formation presented by the coast line from Port Arthur to Pigeon River. Position and distribution of upper division beds.

The traps are not only visible as mentioned as vertically columnar beds capping the hills, but also exist at various lower levels. Whilst some of the highest might possibly be portions of a crowning overflow separated from each other by denudation and brought to different levels by faulting, the evidence seems to leave no doubt of the existence also of numerous other sheets at very various horizons in the formation, and the intrusive nature of some of these appears from a close study of them on the ground to be quite assured. The observed instances of this are mentioned later on in this Report in describing the different districts in which they occur. In view of all the evidence, it would seem then that the trap-sheets are not confined either to the lower or the upper division of the formation, although they seem to occur more frequently in the latter. Trap sheets.

As has been already mentioned, the formation lies nearly flat, and it is very difficult to decide whether it really has any general dip or not. The dip measurements obtained both in the examination of the new silver districts west of Port Arthur and along the coast section south of that place, whilst ranging usually from 5° to 10°, were so conflicting in direction, and were evidently so often rendered unreliable by the proximity of disturbing influences such as dykes, veins, intrusions of trap, etc., as to leave it in doubt whether the rocks have any general dip, and if so, what its amount and direction is, or whether they are bent into a series of flat anticlinal and synclinal ridges, troughs and basins such as were commonly seen to exist along the coast section. This question will have to stand in abeyance for satisfactory settlement until the whole district comes to be thoroughly worked out, but meanwhile it would seem that the balance of evidence is in favor of the existence of a general flat southerly and south-easterly dip of the whole formation, probably averaging from 5 to 8 degrees. Dip of formation.

If we assume the average dip to be 5° in a S.S.E. direction, and measure the width of the outcrop of the formation from Grand Portage Probable thickness of Animikie formation.

Island, where it passes under the overlying Keweenian rocks, N.N.W. to near Woodside's vein, in the Silver Mountain area, where the Archean appears from below them, which we find to be some 25 miles, we get a thickness for these rocks of over 12,000 feet.

Contents of veins

The silver ore of the district consists of the native metal and sulphide or argentite generally associated with blende, galena pyrites, etc., in a gangue of calcite, barite, quartz and fluorite in a series of fissure veins the details of whose characteristics are dealt with later.

Vein groupings.

Such, then, are the general features of the Animikie or silver-bearing formation of Lake Superior. In considering the details of the various mining discoveries and experiments the veins historically, and naturally fall into the following groups, and will be hereafter considered in that way, viz.:—

1. The Coast Group.
2. The Port Arthur Group.
3. The Rabbit Mountain Group.
4. The Silver Mountain Group.
5. The Whitefish Lake Group.

The Coast Group.

Distribution.

This group comprises a series of veins located on the coast of Lake Superior between Port Arthur and the International boundary at Pigeon River, and on the group of islands in the mouth of Thunder Bay.

"Country rocks."

The greater number of these intersect what was formerly known in the district as the "Macfarlane Band," a belt of trap dykes and associated intrusive sheets, with argillaceous beds filling out their interspaces, constituting the string of islands between Silver Islet and McKellar's Point and considered to be the continuation of the Silver Islet dyke. The chief mine of this group is *Silver Islet*, and the great success attending the opening up of this vein caused great excitement in the district and directed the attention of explorers to the series of veins already mentioned, upon the supposition that whereas the Silver Islet vein had only been productive where it intersected the dyke, that therefore the presence of silver was due to its influence, and that all other similar veins intersecting its supposed extension would be found equally rich. The rocks enclosing the veins along the coast line consist of argillaceous beds which, in places, are so siliceous as to constitute argillaceous sandstones and flagstones, whilst they often merge on the other hand into dolomitic argillites.

Trap sheets.

With these are associated also numerous trap-sheets which are seen to occur both capping the bluffs overlooking the shore, and also at lower horizons in the formation.

Trap dykes.

Trap dykes are also very numerous, constituting, as they do, nearly all the capes and points of the coast. They nearly all strike N. E. & S.W., or at right

angles to the system of vein fissures. Further details regarding these rocks are given later on.

The gangue of this group of veins consists mostly of quartz, fluorite, calcite and barite, and they carry native silver, and silver glance associated with much zinc blende and galena and sometimes some copper sulphurets. Vein contents.

Apart from the work which was going on at *Jarvis Island* and *McKellar's Island* (the latter for barite) none of the mines of this group were working at the end of 1886.

Silver Islet Mine.

This having been the most extensive and most successful venture of the region, I have gone into its history and nature somewhat at length. It is situate on a vein crossing a small rocky islet about a mile out in the lake off Thunder Cape.

The vein strikes N. 35 W. and dips to the S. E. at an angle of about 70° to 80°, whilst in thickness it would average about 8 to 10 feet. In some places, however, it has shown from 20 to 30 feet of solid veinstuff. At the time of my visit the mine had been closed for some time, and was full of water, so that beyond making an examination of the surface I have had to depend for further information on various published accounts of the mine, chiefly by Messrs. Thomas Macfarlane W. M. Courtis, and F. A. Lowe, all of whom were connected officially with the mine at various times. From these sources and from information supplied by Mr. Richard Trethewey, the manager, who was in charge of the underground department since December, 1871, and took charge of the whole work from 1876 to its close, as well as from my own observations, I have been able to compose the following history and description of the mine Vein characteristics.

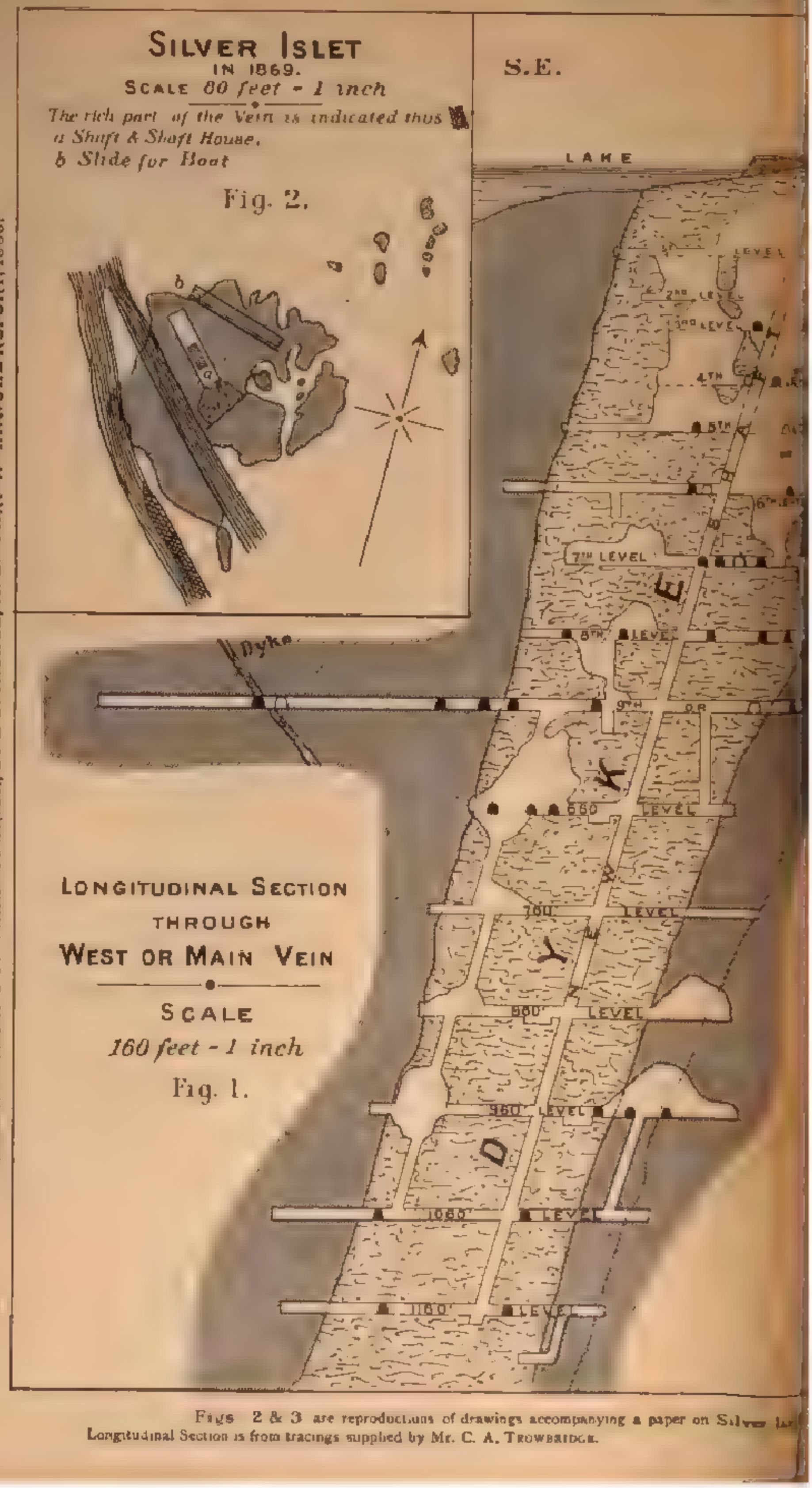
The gangue of the vein consists of calcite, quartz and dolomite, the latter varying in color from cream to pink, according to the varying amounts of manganese it carries Mr. Courtis also mentions having found rhodochrosite in the ore shipped to the Wyandotte smelting works. The metallic minerals are native silver, argentite, galena, blende, copper and iron pyrites with marcasite. Mr. Macfarlane also mentions tetrahedrite, domeykite and niccolite and cobalt bloom, the two latter, probably, oxidation products of a peculiar mineral called Macfarlanite, containing arsenic, cobalt, nickel and silver. Two new minerals are also said to have been found in the ore, by Dr. Wurtz, called by him Huntelite and Animikite. The three latter, according to Mr. Lowe, "are now" (October, 1881) "the principal producing silver ores of the mine" (E). Besides the above, Mr. Courtis found in the Vein contents. Metallic minerals.

ore shipped to the Wyandotte smelting works, annabergite, antimonial silver and cerargyrite, the latter " where the rock has been decomposed " (A). Graphite also occurs in considerable quantity and seems to be connected in some way with the occurrence of the silver. On enquiring of Mr. R. Trethewey as to what connection he had noticed between the existence of this graphite and the occurrence of the silver, with a view to ascertain its value as an indication, he told me that although they never had silver without graphite, they sometimes had graphite without silver. " The native silver is generally disseminated through the ore in more or less dendritic masses, the points of native silver forming nuclei for the deposit of niccolite and sulphurets " (A). In a specimen of the ore collected by myself are to be seen pieces of trap and graphite enclosed in pink spar, whilst from the graphite start out dendrites of silver. " Particles of silver were also found in some of the small feeders which intersect the country rock (or perhaps *horse*) lying between the two veins " (C). The vein splits in crossing the islet going south but according to Mr. Lowe, comes together again both in length and in depth at the fourth level, after which they continue both in length and depth as one vein, with an average width of 8 feet. " The southern part of the latter " (the western) " branch carried the richest ore, the eastern branch being less rich, and the whole of the vein to the northward being almost entirely barren and consisting of a huge mass of calc-spar with quartz and occasional cubes of galena which carry only a minute quantity of silver " (C). Mr. Hoffmann recently examined some large crystals of galena given me by Mr. R. Trethewey which the latter said came from a vug at the 560 feet level, and found only a trace of silver. " The blende, galena and pyrites are generally very poor in silver, seldom exceeding 2 oz., per ton when taken from the barren parts of the vein, but in and about the rich silver deposits, they become highly enriched both chemically and mechanically.... by particles of and streaks of native silver " (E). " The relative quantity of calcareous and siliceous matter varies, however, in different parts of the vein, and in some places, streaks of quartz have preponderated to such an extent as to make some of the ore highly siliceous." (C). A curious feature of the vein is the combustible gas which has been met with in large quantities in the workings. This gas, according to Mr. Lowe, is accompanied by water containing calcium chloride in solution. He says: " Two gallons of this water furnished, roughly measured, nearly a pint of very acrid and deliquescent salt, chloride of calcium." (D.) He further states " the gas and water are principally confined in large vugs or cavities in the vein under great pressure......it" (the gas) " is met with in the deepest

GEOLOGICAL AND NATURA

ALFRED R. C. SELWYN, C

MINES AND MINING ON LAKE SUPERIOR, BY E. D. INGALL, M. E.—PART H—ANNUAL REPORT, 1886.



Figs 2 & 3 are reproductions of drawings accompanying a paper on Silver Is
Longitudinal Section is from tracings supplied by Mr. C. A. Trowbridge.

TORY SURVEY OF CANADA.

L. D., F. R S., DIRECTOR.

Plate I.

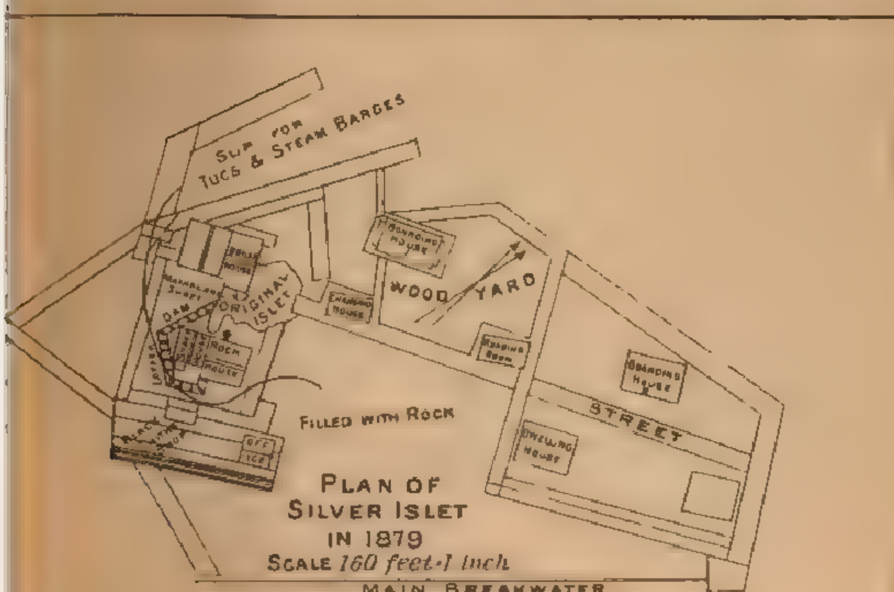


Fig. 3.

Thomas Macfarlane, in the Trans. American Institute of Mining Engineers for 1879-80. The

workings......above the 8th level all water infiltrating into the mine is pure lake water, whilst below that level is a zone of highly mineralised water......the gas is unequally distributed through the lower workings, occupying independent cracks, fissures and vugs....the water annoyed the men very much; on touching their skin it would almost blister it......it" (the gas) "was also previously met with in the 3rd and 6th levels." (D.) Mr. Macfarlane also mentions the occurrence of this gas on the 8th level in a vug.

Mr. G. C. Hoffmann, chemist to the Survey, having analysed a sample of this water which was collected by Mr. Richard Trethewey at the instance of Dr. Selwyn in the summer of 1882, reports as follows. * After giving the details of the analysis, he says: "Total dissolved solid matter by direct experiment dried at 180 C. 35 9566" in 1,000 parts by weight. "The foregoing acids and bases are most probably combined in the water as follows (Carbonates calculated as mono-carbonates, and all the salts estimated as anhydrous.) — Analysis of mine water.

Chloride of Potassium	.4582
" Sodium	16 8098
" Calcium	17.0807
" Magnesium	1.2937
Sulphate of Lime	.0672
Carbonate of Lime	.2936
Silica	.0540

"The rock on the Islet intersected by the silver vein is a chloritic diorite, evidently forming a dike.† It differs somewhat from the rocks of the other dikes of this location among which may be mentioned cossyte and anorthite porphyry......gray flags fill out all the — "Country rocks"

* Geological and Natural History Survey of Canada. Report of progress, 1885, sec. M, page 17.

† Prof Roland D. Irving describes these rocks as follows:

"Between Thunder Cape and Silver Islet a large number of dikes are seen cutting the slates. Only one of these dike rocks, which appear for the most part to be the same as those which form the numerous dikes of the South West shore of Thunder Bay, already described, was examined. This is the rock which forms the dike at Silver Islet. It is a nearly black, rather fine grained rock, distinctly composed of a greenish black and a white mineral, the latter being of course felspar. According to Macfarlane its specific gravity is 2.7 and its silica content 53.31 per cent. It contains 5.02 per cent of water, an amount indicating a considerable alteration, and this indication is fully borne out by a microscopic study of the thin section. This shows tabular plagioclases with some orthoclases as predominating ingredients. These felspars are all much dulled by alteration and are often penetrated by secondary quartz. In many places the larger felspars have between them a mass of smaller, much crushed and always highly altered felspars The augitic ingredient is only partly fresh, being commonly much altered to ochre, and uralite with which alteration is connected the formation of some magnetite, Rather abundant titanic iron for the most part altered to its characteristic gray decomposition product and sparse apatite complete the resemblance between this rock and the finer orthoclase gabbros of the Keweenawan." See monographs of the United States Geological Survey, Vol V "The Copper Bearing Rocks of Lake Superior" by Roland D. Irving p 378.

spaces between the various dikes." (C). The vein "has been exposed at several points where it crosses the sedimentary beds, but there it is split up into numerous thin veins of quartz, and shows nothing of the great width which it carries on Silver Islet, nor have any of the rich silver minerals of that locality yet been found upon the mainland or upon Burnt Island" (C). This diorite dyke dips S. E. at an angle of from 60° to 75° from the horizontal, and is faulted some 80 feet by the vein. "The workings have never been productive outside of it, indeed there are large areas of the vein enclosed by diorite walls on both sides which have yielded no ore." (C). "The long" (diamond drill) "holes E. and W. on the 1st level proved that the dyke was saturated with graphite which is also noticed in its outcroppings known as Pyritic and Ship islands, one and five miles from the mine. Out of the whole series of twenty-one dykes cut by the vein,......the Silver Islet dyke is the only one impregnated strongly with graphite and pyrites" (D). "The influence of the country rock upon this vein is very apparent from the development on the 6th level N. and on the 9th both N. and S. In both levels on entering the schists" (? slates) "the vein gradually thinned out to mere stringers, but recovered its width on entering two other dykes N....and the vein in them was highly mineralised...... In drifting south, a small dyke of a few feet in width was met with" (D). Regarding the connection supposed to exist between the *floors* which cross the vein at intervals and the occurrence of the silver ore. Mr. R. Trethewey told me that they were not necessarily to be regarded as an indication, as has often been alleged, for although there seems to be some little connection in the upper and richer part of the mine, they had the same floors below that in the poorer part, but they were unaccompanied by silver. However, in a general way, if on coming on to a *floor* it was found to be covered with patches of argentite, it was mostly a sign that the rock down to the next *floor* would be rich, though sometimes the silver would not be found for some little depth below such a floor.

Dykes impregnated with graphite.

Influence of *floors* in vein.

History of mine

Discovery.

History of the Mine.—The *Silver Islet* vein was discovered in the summer of 1868, during the exploration of the lands of the *Montreal Mining Co.* by a party under the direction of Mr. T. Macfarlane which, on leaving in the fall, after the summer's exploration of this and other properties, the party brought away with them specimens valued at $1,200 taken from the outcrop of the *Silver Islet* lode. During the summer of 1869, Mr. Macfarlane continued his work of surveying and exploring Woods' location, of which the Islet forms a part, and notwithstanding a stormy summer, rendering work on the Islet difficult, some 9,455 lbs. of ore were produced and shipped to Mont-

real, valued by assay at $6,751.67. In August of 1869, the same party began to sink a shaft on the Islet on the east branch of the vein, intending to cross-cut to the western or richer branch, and a party of twelve men with a horse were left to continue this work during the winter of 1869-70. They were instructed to take advantage of the formation of ice around the Islet to continue the extraction of the ore from the outcrop of the western or main vein which was under water alongside the Islet. The winter was favorable, the ice having formed quietly and remained for two months, so that the efforts of the party were successful, and by the spring they had, by subaqueous blasting, and fishing up the product with tongs, etc., enough rock to yield by sorting 17,669 lbs. of ore, whose total value by assay was $18,291.39. This ore was shipped to Montreal in the spring of 1870. The shaft, however, had to be discontinued on account of water. "That ten men had been able to produce $16,000 worth of ore, and that the actual time employed by them in so doing had not exceeded fourteen days, was again insufficient to induce the *Montreal Mining Co.* to proceed to work the Silver Islet vein" (C). Work commenced.

After some negotiations, the whole of this Company's property passed into the hands of New York and Detroit capitalists in September, 1870, and on the 31st August, Captain Frue arrived and commenced work with a party of about 30 men and two horses accompanied by the necessary provisions, etc. "In spite of severe weather extensive breakwaters were built, part of the vein enclosed by a cofferdam, the area within the latter pumped dry, a considerable amount of mining done, and about 77 tons of ore shipped before the close of navigation. The time devoted to mining was about four weeks ...... About $80,000 were expended in the above operations, and in making provision for wintering" (C). The total value of the ore in this parcel was $92,153.23. The winter of 1870-1 was taken up by Mr. Frue and his party in enclosing the Islet with cribbing, so as to establish a permanent mine there. The difficulties experienced from the storminess of the season and trouble with ice were very great, both in placing the cribbing and in keeping it in place, and gales took away most of it, which had to be replaced. Change of ownership.

"By the 1st May, 1871, an excavation had been made on the rich part of the vein inclosed by the cofferdam having a length of 65 feet, depth of 32 feet and an average width of 8 feet. By the close of navigation in November, this working had attained a depth of 90 feet, and had produced from the same time in 1870 about 485 tons of ore" (C)., and had thus in the year, Nov. 1870 to Nov. 1871, produced ore carrying silver, worth by assay $642,932.01, and also one lot of five tons,

Continuation of history of mine

worth $5.200, which was lost in transit on the propeller Coburn.

"Mining was continued with varying success after the close of navigation in 1871. The vein was found to be subject to frequent and sudden changes, both as regards size and richness. In the fall of 1871, it narrowed down to 6 inches in width at some points, with scarcely any first quality ore in sight. During the winter, it gradually widened and became very productive. In Mr. Frue's reports many such alternations are recorded. He says that in the summer of 1872, 'the lode became broken up, being thoroughly mixed with diorite and wedges of plumbago, and in the fall, the mine assumed anything but a flattering appearance.' Mr. Frue further writes on this subject as follows: 'In the following winter it suddenly changed in character and produced, up to May 1st, 1873, 250 tons of rich packing ore worth about $1,500 to the ton. During May, and the early summer, the vein disappeared almost entirely, being broken up into strings and feeders. Later, however, there was a decided improvement which was again overshadowed by a passing cloud, and although in extending the drift north on the 40, a very promising show of silver had been opened, I had often seen the mine clothed in richer apparel than it appeared at the close of navigation.' (1873)." (C).

During the winter of 1873-4, severe storms did considerable damage to the cribwork protecting the Islet, amounting to over $11,000, besides carrying away the upper portion of the main breakwater and doing other damage. The unfavorable changes which occurred in the fall of 1873, continued up to the close of 1876." The new levels which had been opened up, the 8th and 9th, proved wholly unproductive, although no difficulty was experienced in following and working on the vein. A vast amount of exploratory work by means of the diamond drill, also failed to discover any deposits of rich ore. The consequence was of course great financial embarrassment and an almost entire cessation of work during the summer of 1877. In August of that year, work was resumed, and up to December, 23,850 oz. of silver obtained by stoping in the upper part of the mine. It was even proposed to remove the rich ground lying betwixt the mine and the lake, substituting for it an artificial arch, but fortunately, in the summer of last year" (1878), "a bunch of rich ore was struck beneath the 4th level S. of the shaft which in a few months yielded 721,632 oz. of silver, a quantity amply sufficient to rescue the mine from all its embarrassements and provide a reserve or working capital of $300,000" (C).

Mr. Lowe describes this period of the mine's existence as follows. Speaking of the first bonanza, he says it "extended for a distance of 100 feet on the hanging wall of the main vein, and for nearly a like distance

upon the same wall of the east vein. It varied from 6 inches to over 2 feet in width, finally disappearing below the 6th level. The silver did not crop out in the east vein, but was found in cross-cutting through the horse of diorite on the 1st level. It extended upward within 40 feet of the outcropping. It was completely worked out by 1874, yielding over $2,000,000 .... The shape of this bonanza was that of an irregular pear and throughout its extent in both veins it was accompanied with a strong impregnation of graphite which formed the selvage of both veins. The bulk of this bonanza was arborescent silver, more or less mixed with Macfarlanite, a rich ore of silver carrying 78 per cent. of that metal along with arsenic, cobalt and nickel. Its physical structure resembles niccolite....The years from 1874-8 were devoted entirely to exploring, and but little silver was mined." (D.) During this period the new inclined shaft was started from the 9th level, diagonally across the vein, and on the pitch of the same. "Previous to the sinking of this shaft, the diamond drill was extensively used in different parts of the mine.... long holes were driven N. & S. on the 1st level. In one of them, silver was struck, but it proved to be only a small pocket. On this level, 400 feet holes were driven E. and W. for parallel veins; 40 feet west a small vein was struck." (D.) but subsequent testing by cross-cut and drifting showed no silver. "On the 3rd level, S., another series of holes was driven, and one of them, which was subsequently proved, skirted along within a few inches of the second bonanza..... The small pocket of silver struck on the 1st level, S., was followed later on by a considerable streak of argentiferous pyrites, running 2,000 oz. per ton, lead with 800 oz. per ton and native silver. This streak was cut near the junction of the two veins on the hanging wall in a cross-cut and extended down as far as the 2nd level.......The writer has since learned that another small bunch was struck S. of this point on the same level." (D.). He further says in reference to the before mentioned second bonanza. "In drifting south on the 3rd level in August, 1878, strong impregnations of graphite were met on the hanging wall which were soon followed by the second bonanza. This deposit of silver was remarkable for its great width, 5 feet solid across the breast, and the occurrence in great quantity of two hitherto unknown compounds of silver, namely, Animikite and Huntilite. The shape of this bonanza was that of an inverted cone with a base of about 50 feet on the 3rd level with the apex down as far as the 5th level. This deposit was phenomenal in its structure and a winze in the middle of the deposit to the 4th level, sixty feet, was sunk literally through native silver, the metal standing out boldly from the four walls of the winze. In the breast of the drift it stood out in great arborescent masses in the

First bonanza.

Period of adversity.

Second bonanza.

shape of hooks and spikes, in gnarled, drawn out and twisted bunches, followed by arborescent silver with intercalated bands of Animikite and Huntilite. This deposit was struck near the junction of the two veins and the whole extent of the bonanza was strongly saturated with graphite carrying a selvage of the same in the hanging wall three inches thick. The hanging wall was as smooth and as polished as a mirror, with horizontal striæ....The width of the vein was over 10 feet, and the entire deposit, including the stamp rock, yielded about 800,000 oz. of silver. An interesting fact connected with this deposit was noticed in the manner in which the arborescent silver was disseminated throughout the whole width of the vein, and in the concentrated parts and the manner in which it was impregnated through a series of horizontal floors in the vein. These floors did not break or separate the deposit. This deposit paid off the bonded indebtedness, leaving a surplus of $300,000, which, however, was expended, along with six assessments, in the construction of the new shaft to the surface, and sinking of the same 500 feet below the 9th level, in driving five levels N. and S. from the same, equipping it with new pumping machinery, developments in the upper parts of the mine and two years' work on Burnt Island and the mainland." (D.)

"Floors" in vein.

Yield of mine.

Mr. Macfarlane's description continues:—"I have not found it possible to ascertain the amount of the product year by year subsequent to 1875, but according to information received from C. A. Trowbridge, Esq., Secretary of the *Silver Islet Co.*, there have been extracted since the commencement of operations in September, 1870, and up to the close of navigation in 1878, 2,174,499 ½ozs. refined silver with a value of $2,921,727.24. If to this we add the value of the ore obtained immediately after the discovery by the *Montreal Mining Co.*, we have a total yield of $2,948,019.81" (C.) He further adds that he had since learned from Mr. Trowbridge that the precise yield (up to the end of 1879) was $3,039,557.49 and continues "when visiting the mine in July, 1877, the vein appeared perfectly well defined on the 9th level, but nothing in the shape of ore was to be seen The vein was said to possess the same character in the inclined shaft sunk 100 feet deeper than the level, and to a point about 640 feet from the surface. This shaft was filled with water at the time of my visit. The vein below this point has been tested by a drill hole 296 feet deep, in which traces of silver ore were detected. Even if we suppose this trace is the clue to another *bonanza*, the fact still remains that from the 6th level to the deepest working, a distance of 300 feet, the vein has been found to be unworthy of excavation, and this too in spite of the presence of diorite on both walls, a condition which, when the mine was first opened was supposed to ensure a remunerative vein" (C).

Barren stretch of vein.

The foregoing gives the history of this mine up to the end of the year 1879, as recorded by Mr. Macfarlane and others. Mr. Low's paper, from which I have taken the following items, brings it up to December, 1882:—

"On the 9th level a small bunch of silver was struck accompanied with graphite.......From 1878 to the present date" (December, 1882), "the mine has been passing through its second period of adversity, although in that time silver has been struck in various parts of the mine below the 9th level. The only important deposit met with was on the 13th level south. This was also accompanied with a graphite impregnation, but from its irregular and detached condition it did not augur well for a large deposit. It yielded about $30,000.......Gas and water were struck in considerable volume. The new inclined shaft is now down nearly 1,200 feet, with a strong, highly mineralised vein in the bottom, the vein being 9 feet in width" (D). Second period of adversity.

Mr. R. Trethewey states that the mine had attained a depth of 1,230 feet before the cessation of operations. I have it on his authority that at 80 feet north on the bottom level, they had a good bunch of ore. He also tells me that the total yield of the mine from its commencement to its close in 1884, was about $3,250,000. Total yield of mine.

Exploratory work was done on other parts of the vein which was traced inland for about a mile from the shore, making the length of the vein thus known, counting from the Islet, about 9,000 feet. In traversing this distance, it intersects many trap dykes which, however, do not seem to favorably affect it. Three shafts have been sunk to test it at various points along this inland portion, attaining the respective depths of 40 ft., 100 ft., and 60 ft., and a great deal of surface trenching has been done. This work did not, however, result in any discoveries of importance, but Capt. R. Trethewey told me that they had got some galena running 19 oz. of silver to the ton at Morgan Junction shaft (the furthest inland). He tells me they got no plumbago at any of these places. At the latter point, where the shaft is sunk at the intersection of the vein with a dyke of compact trap, I noticed in the dump a quantity of iron pyrites accompanied by a little copper pyrites in a vein stone consisting of argillite cemented together by calcite. The series of dykes crossed by the vein on the mainland differ in appearance from that on the Islet consisting as they do of dark compact trap, whilst the latter is much coarser grained and carries much iron pyrites. Besides the beforementioned shafts one was sunk on the vein where it crosses the dyke forming Burnt Island. These dykes are faulted by the vein and are, therefore, older than it. Mr. Lowe says that the diamond drill was also used extensively on Shangoinah Island and on Burnt Island. Work done on vein on mainland. Work on vein on islands.

Expenditure and [redacted]

Mr. Curtis writing in February, 1877, sums up the history of the mine as follows:—"A capital of $73,000 paid a dividend of $160,000 the first year, besides paying about $200,000 towards settlement with the *Montreal Mining Co.*, and expending also a large amount of money to establish the plant. In the report for this year" (1877,) "we find that the total amount of dividends have been $622,666.66, and the total production $2,237,479.84. This great outlay was needed at the mine to establish a town on a barren rocky shore, to maintain a foothold on a little rock not 80 ft. square against the mighty storms of Lake Superior, to furnish steam-tugs, engines, pumps, and build a mill capable of concentrating over 75 tons of rock per day" (B).

Mr. Lowe states that more than $1,200,000 were expended in securing the Islet, also that the volume of water made by the Silver Islet vein per minute was about 170* gallons, its principal source being above the 9th level, and further that throughout the mine nearly 5,000 feet of holes were bored by the diamond drill.

Diamond drill holes.

Statistics.

The below given tables show the yield of the mine year by year, and are compiled from Mr. Macfarlane's paper above quoted and the other sources mentioned.

	Weight in Lbs.	Value per Ton.	Total Value.
		$ c.	$ c.
Under Montreal Mining Co.	27,073¾	1,646.80	23,115.35
" New Proprietors, 1870	155,543	1,175.80	92,153.23
" do 1871 (Newark)	183,453	1,507.64	138,291.88
" do 1871 (Wyandotte)	778,468½	1,296.48	504,640.13
Lost on propeller "Coburn"	10,000	1,040.00	5,200.00
	1,154,537¼	$1,322.44	$763,400.59

Season 1872	310,744.02 ozs.		
" 1873	289,763.77 "		
" 1874	250,021.75 "		
" 1875	145,902.50 "		
	996,432.04 "	=	$1,195,718.45

Carried forward $1,959,119.04

* Mr. Richard Trethewey says 155 gallons per minute is the correct figure.

Brought forward		$1,959,119.04
Produced by stamp mill, Dec. 1875, to Nov., 1876 (concentrates)	136,529.00 ozs.	163,835.00
Produced by stoping in upper part of the mine, 1877	23,850.00 "	28,620.00
Produced from second *bonanza*, 1878	721,632.00 "	865,958.00
Produced from deposit at 960 ft. level, about 1882. (Mentioned in Mr. Lowe's paper.)		30,000.00
Total of amounts mentioned in various accounts of the mine as above		$3,047,532.04
Amount unaccounted for above		202,467.96
		3,250,000.00
Total value of silver produced from the commencement to the close of operations, according to Mr. Richard Trethewey		$3,250,000.00

This discrepancy of $202,467.96 is not necessarily due to an actual disagreement of the different authorities, but probably represents the results of the treatment of mill rock taken out from various parts of the mine which had been neglected during its palmier days, and to which attention was turned after the mill was built and the rich ore bodies were worked out.

The last authentic statement regarding the mine is found in the official report of Mr. Richard Trethewey, dated January 20, 1884, to the President of the Company, where he says "The work at the mine during the past year has been devoted to the sinking of the shaft to the 1,160 feet level, drifting the same north and south of the shaft, sinking two winzes below the 1,160 feet level, and back stoping at encouraging points in some of the upper levels.......These drifts" (from the 1,160 feet level) "have been extended southward 227 feet and northward 81 feet. The vein, though well defined and carrying quantities of minerals, has not produced the expected amount of silver. A deposit of silver was opened into during the summer, near the end of the north drift, but proved to be small in extent. At this point and in this run of ground a winze is being sunk towards the 1,260 feet level, hoping that in its course other bunches may be found. A winze has also been commenced towards the 1,260 feet level, near the end of the south drift in the same run of ground in which silver has been found above. In the levels where back stoping has been carried on, the vein, although of a very encouraging nature, yielding minerals which are always found accompanying silver, has not produced silver in paying quantity; still it will be remembered that heretofore we have worked for long

Latest developments.

periods in ground such as described and finally been rewarded by encountering rich deposits, and there is no reason why we should not expect similar results again." He continues thus: "Ere long we shall find ourselves placed in a serious dilemma owing to the non-arrival of our winter supply of coal last fall—a vessel with a cargo of nearly 1,000 tons having failed to reach here, being laid up while *en route*. The present supply of coal is sufficient to run with until about March 1st, after which we shall find it extremely difficult to carry on the work." Operations were accordingly suspended early in the spring of 1884.

Closing of mine

Description of illustrations.

Plate I shows the underground workings of the mine on the west or main vein. I have not been able to obtain a section showing the same for the eastern branch above its junction with the main vein at the fourth level, but Mr. John Trethewey tells me it was mostly stoped out from the fourth level to surface, being worked by cross-cuts from the main vein from which levels were driven on it. The tracing from which the illustration was taken was apparently not kept quite up to date, for some of the measurements given me by the manager do not quite coincide with those of the tracing; these differences, however, are trifling and do not affect the utility of the drawing as an illustration of the direction and extent of the underground development made upon this famous vein.

Stamp mill.

During the first few years whilst the very rich ore of the first deposit was being worked out which had only to be barrelled up and sent to the smelter, the poorer mill rock was neglected, and it was only when the period of adversity was experienced, that attention was paid to it, and a stamp mill erected on the mainland at a cost of about $100,000 to treat it. This work was carried out in the winter of 1873-4.

The machinery used consisted of 50 head of stamps, 24 Frue vanners (an improved form invented by Captain Frue of the old Brunton frame) and two No. 4 Blake crushers with the necessary hoisting gear, water tanks, etc., and a 250 horse-power engine to supply the necessary power. The ore as it came out of the mine was dumped by the self-dumping skip into cars and brought thence to the mainland on a scow towed by a tug. These were then hauled up an incline to the mill where the ore being dumped and fed into the Blake crushers, passed from them to the stamps. The battery slimes passed directly to the Frue vanners, which were arranged in two sets, one below the other, the upper or head tables and the lower or clean-up tables. The tailings from the former passed to the latter, and were there further concentrated, the heads or concentrates being barrelled up and sent to the smelter. The heads from the lower set were passed over to extra clean up tables to be further concentrated. The mill had a capacity of

about 60 tons per day, producing from 1 to 2 tons of wet concentrates, holding about 14 per cent. of moisture, at an average cost, according to Mr. Low, of $1.70 per ton. The concentrates varied in their value from $300 to about $10,000 per ton, but averaged between $500 and $1,500. Mr. Lowe states that the tailings averaged about $2 per ton, and that the mill saved 90½ per cent. of the silver in the ore. The rock put through ran from 6 to 37 oz. per ton.

Cost of milling.

To Mr. Richard Trethewey I am indebted for the following items regarding cost of production calculated per ton of rock milled:—*

Mining	$2.50 (to $3.00)
Sorting	50
Labour and tug expenses, transporting rock from mine to mill	50
Crushing, stamping and dressing	2.00
Total	$5.50

Smelting of ore, etc.

In the early period of the existence of the mine there seems to have been considerable difficulty in making satisfactory arrangements for the sale of the ore. The assays made of some of the first lots by different assayers varied greatly, and furthermore, the smelting charges were very high. "Both at Newark and Wyandotte, the smelters only guaranteed to return 95 per cent. of the silver contents and charged $100 per ton for smelting," says Mr. Macfarlane, and the smelters naturally refused to account for more silver than was shown by their own assay. These discrepancies no doubt arose from the natural difficulty of getting uniform samples from so very rich an ore, and one containing so much metallic silver.

Wyandotte smelting works

In consequence of this, the Company determined to erect smelting works of their own, and this was accordingly done and smelting was commenced at the Wyandotte works by July 1st, 1871. Of these works Mr. W. M. Courtis, in a paper read before the American Institute of Mining Engineers, Oct. 1873, says "The intention was to work Western ores with those from Lake Superior, since the latter contain but a small amount of lead. Hence the capacity of the works is much larger than is needed for the present yield of the mine. The planned process for treatment was, smelting with lead ores, desilverizing the lead by Balbach's process with zinc, cupelling the rich lead and refining the crude silver. Since the supply of Western ores was uncertain, and prices and freights were high, a sufficient supply could not be obtained; and hitherto the works have been in operation but a few months each year.

* For further details see Appendix B.

Yet they have produced a very large amount of silver—931,203 oz. in fine silver up to Sept. 1st, 1873. The process has been smelting for rich lead at once and cupelling and refining the bullion. In addition has come: treatment of the matte to save the nickel; refining the nickel matte; extracting the silver from the marketable nickel speiss, and treatment of the refuse too poor for smelting."

Other veins of Coast Group.

I have gone somewhat fully into the history of the Silver Islet mine, as it was the chief and typical mine of the district. In order to show how far the rest of the veins of the group under consideration have been tested as to their value, I have added below all the data obtainable, either from personal observation or otherwise, regarding the developments made on the other veins of this group and referring to their conditions of occurrence.

Angus Islands.

About ten years ago, a vertical shaft is said to have been sunk on one of the islands, and a drift run out from it to intersect the vein which could be seen outcropping under water near the shore. No success seems to have attended this effort.

McKellar's Island.

This vein was discovered in 1869 by the Messrs. McKellar Brothers, and some years afterwards the test work was done, shown in the accompanying drawing of the mine. (See Plate II, Figure 2).

Vein characteristics.

It is very large, consisting of coarsely crystallised, calcite and barite, occurring in separate ribs for the most part, although they are mixed in parts of the vein. With these preponderating minerals there is a smaller proportion of quartz, generally colourless. The metallic minerals consist of zinc-blende with a little galena and pyrites which are for the most part concentrated in dark coloured bands in the main vein, of which bands there are two on the north side and one on the south side of the island. A sample of one of these streaks assayed—gold, none; silver, about ½ oz. whilst another from a different place in the same gave neither gold nor silver, showing that the dark coloration was not due to finely disseminated argentite or agentiferous blende. (See Report of Progress, Geological Survey of Canada, 1886, part T, assays 33 & 34.)

Assays.

Side branches.

Besides this main vein which is composed of solid spar, and is about 60 feet wide on the south side of the island there are numerous side stringers intersecting the country rock of the west wall of the vein, and on these the developments have been mostly made as shown in the accompanying illustration.

GEOLOGICAL A

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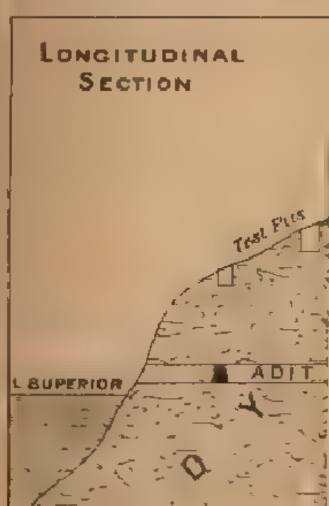
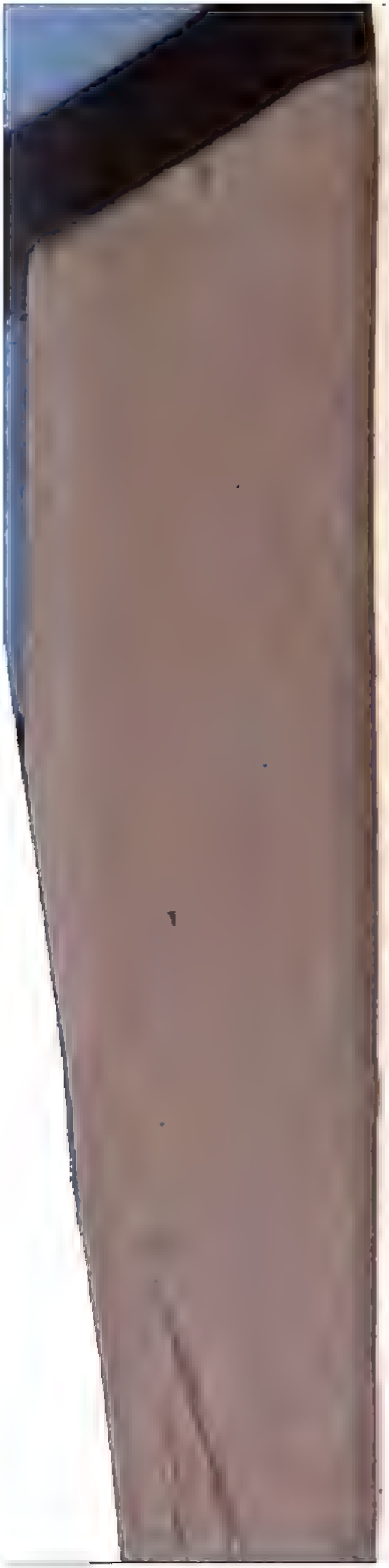
From published Reports, Maps, a



From Sketch survey made by E.

TRAI



The enclosing rock is a dark green, coarse grained trap. This composes the whole island which is only some eight or nine chains in diameter, and is evidently part of the outcrop of a dyke which appears further west in Thompson's Island. A little altered argillite appears on the south side of the island still clinging to the dyke. Enclosing rocks

According to Mr. P. McKellar, argentiferous blende was the chief silver bearing ore of the vein. The developments done so far have evidently not opened up any very large body of or .

During the summer of 1886, the barite rib on the east side of the vein has been worked down from surface, some thirty men being employed at this work, and the product after handpicking to extract as much of the calcite and quartz as possible, was being shipped to the United States, the buying firm giving $5 per ton *over the rail* at the island for the best quality. Worked for barite

Thompson's Island.

This island consists for the most part of trap in the form of dykes running lengthways through it with a small development of the argillites between the two forming the two points at its western extremity. The backbone of the island is constituted by the dyke which forms its eastern extremity, and which is evidently the same as that forming McKellar's island, which it resembles in appearance, being a dark green trappean rock of rather coarse texture. Enclosing rocks.

It was located in 1853 by Mr. T. Macfarlane for the Montreal Mining Co. A small amount of exploration was done in 1873 and in the winter of 1873-4, when some development work was done to test a vein crossing the island at its eastern extremity in a north-westerly direction. It consisted, as far as I was able to see, of an adit level run in on the vein, where it shows in the face of the cliff forming the north shore of the island, for a distance of about 25 feet, from the end of which a nine feet winze has been sunk on the vein, which here consists of an aggregate of stringers and branches of various sizes, covering a width of about four feet. The gangue consists mostly of barite with some calcite and white and amethystine quartz. It carries a small amount of the usual metallic minerals, viz., blende, galena and pyrites. Other veins occur, crossing the island in a north-westerly direction of a very similar nature to the last, and where seen, are all enclosed in trap. Work done. Vein characteristics

Spar Island

This island is part of the old Prince location, and was one of the first worked properties on the lake, operations having been carried on there in the years 1846 and 1849

Rocks of island

It consists, like the others, of a group of trap dykes with argillites, between, which latter rocks attain their largest development at the east end of the island, where they are to be seen forming a cliff about 200 feet in height, and are capped with a thin sheet of columnar trap. They are cut at this place by several dykes running lengthways of the island. Passing along the south shore of the island the same geologic conditions are observable, except that for some distance the argillites are seen to be associated with intrusive sheets of trap. This is visible for some distance along the south shore at one place where in cliffs some 30 to 40 feet high are to be seen three such sheets. That they are intrusive sheets is shown by the fact that they are frequently lenticular and curve up the beds above them out of their plane of bedding, the under side of the trap sheet lying flat on the beds below it. At one place this was found to be the cause of a very sudden change of dip of the argillites from a flat angle to the eastwards to a dip of about 45° westwards. Again, where the covering argillite has been recently denuded away, the remarkably smooth upper surface of the trap sheet further attests to the correctness of this view, these surfaces in no way resembling those polished and grooved by ice which also occur in this region.

Intrusive trap sheets.

Enclosing rocks of vein.

A plan, etc., of the western point of the island where the developments have been made is given in Plate III. Here there are as shown two dykes of trap separated by argillaceous beds and accompanied by an intrusive sheet of trap, on which is left a slight thickness of the argillite originally covering it. The main dyke consists of a medium grained trap whose color is lightened by the presence of white feldspar occurring radiately crystallised, the interspaces being filled out with a dark green mineral, probably hornblende. The smaller dyke "B" is a dark green crystalline trap carrying a quantity of pyrites much more compact than the other, and weathering with a comparatively smooth reddish brown surface in contrast with the gray aspect of the weathered surfaces of the main dyke, which can be seen to be due to the kaolinisation of the felspar. The trap sheet in general appearance and fracture closely resembles dyke "B," and also carries pyrites.

Trap dykes and sheets.

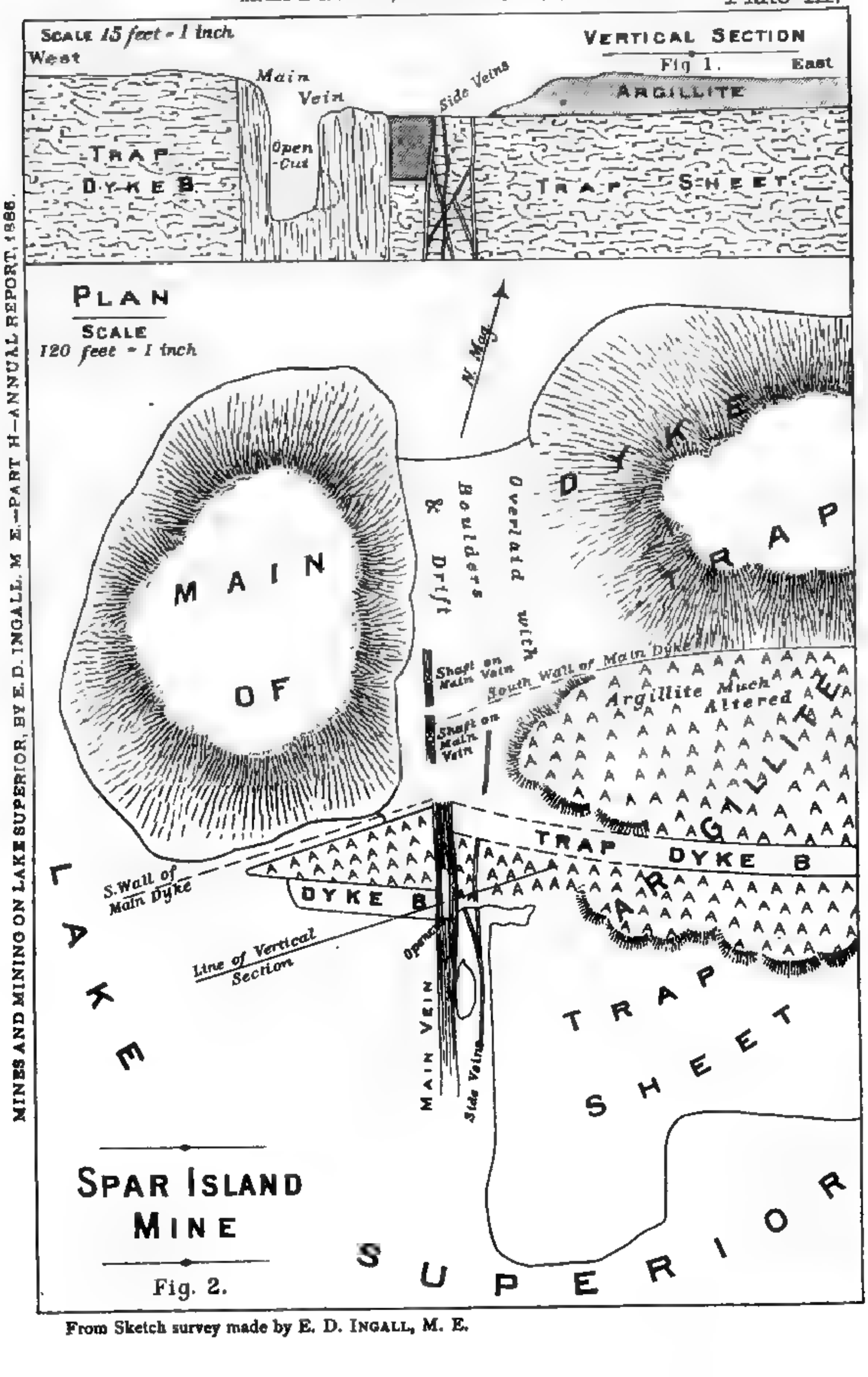
The argillites are of a dark gray color and lie nearly flat. They turn upwards as they approach the main dyke and are much altered. When within about twenty feet of it their bedding becomes obliterated and they take on a confused structure like false bedding, whilst on the fracture they resemble a fine-grained red trap. A similar altered argillite is described later as occurring at Jarvis Island.

Altered argillites.

Veins.

There are several veins visible on the shores of the island running across it in about a north-westerly direction. They show occasionally

Plate III.



From Sketch survey made by E. D. INGALL, M. E.

a little of the usual metallic minerals, blende and galena in a gangue of barite, calcite and quartz. The vein at the western end of the island shown in Plate III, is the only one on which any work has been done. The main vein with which are associated a few side branches is large and filled with a solid gangue of coarsely crystallised barite and calcite, the metallic minerals being represented by copper glance, copper pyrites, zinc blende and a little argentite, which occur for the most part disseminated through about six inches of gangue along either side of a six inch rib of pink barite occurring in the middle of the vein. This fissure has faulted the enclosing rocks about sixty-five feet horizontally. In the Geology of Canada, page 708, it is stated that the two shafts (shown on Plate III) are respectively 24 and 47 feet deep, so that the developments made have apparently not been extensive. It is said that besides the copper minerals found here some rich specimens of silver ore were obtained. Main vein.

Jarvis Island.

This vein was discovered in 1868. It runs across the island in a north-westerly direction and dips N. E. at 50° to 55°, contrasting thus with the nearly vertical dips of the veins of the other islands. In the summer of 1869 Mr. Macfarlane sunk a twelve feet shaft on the vein, "in accomplishing which work the following ore was produced:— History of developments.

79 lbs. first quality ore containing 3.45 per cent. of silver = 39.70 oz. at $1.25	$49.62
2,483 lbs. second quality ore containing 0.15 per cent. of silver=54.18 oz. at $1.25	67.72
Total............	$117.34" (C).

In 1870 this shaft was sunk twenty feet deeper. In 1871 the *Ontario Mineral Lands Company* had a small party working on the lode during the months of June and July, when they sold it for $150,000 to an English company, under whose *regime* quite a considerable amount of work was prosecuted in the way of drifting, sinking winzes, &c. Three shafts were also sunk, of the respective depths of 160, 31 and 78 feet, and some stoping done. Besides this, the necessary surface work, erection of houses, etc., was accomplished, and considerable explorations made on the mainland portion of the property, which latter did not, however, lead to any results. These operations were conducted during the years 1871-2, and were suspended late in the latter year owing to unforeseen financial troubles. In the spring of 1886 the company which had prosecuted this work again commenced operations, and have been working ever since.

Their operations have been chiefly confined to sinking the main shaft and drifting from it Mr. John Tretbewey, who was in charge of the underground department at the time of my visit, was drifting south to get to the contact of the argillites and the dyke, as that was the position in which the ore had always been found at *Silver Islet*. I am now informed that, having been unsuccessful to the south, they are drifting north to get into the argillites upon the other side of the dyke, and that the superintendent, Mr. Arthur McEwan, says that the vein is looking well.

Enclosing rocks. The distribution of the enclosing rocks is shown in Plate IV. Here, as at Spar Island, the vein crosses two trap dykes with argillites in between, which lie nearly flat, but turn down and become much altered on approaching the more northerly dyke, as they do under similar conditions mentioned in speaking of Spar Island. A description of the microscopic characteristics of this rock is to be found in Appendix I., Specimen No. 127. Near the southern dyke the argillites are turned upwards, but there is little or no alteration. The most northerly dyke shows two varieties, the one a rather coarse grained rock, in which the hornblendic mineral, being mixed with white felspar, gives it a greenish-gray appearance; whilst the felspar of the other, being red, gives a redder color to the rock. A description of the microscopical characters of this rock will be found in Appendix I., Specimens Nos. 113 and 128. The vein on which this work has been done is somewhat similar to the two last described, the gangue being made up of the same minerals. It is from ten to fifteen feet thick, and the different minerals are arranged in bands more or less parallel with the strike of the vein. I notice the following succession at one point on the outcrop of the vein, in going from west to east across it:—

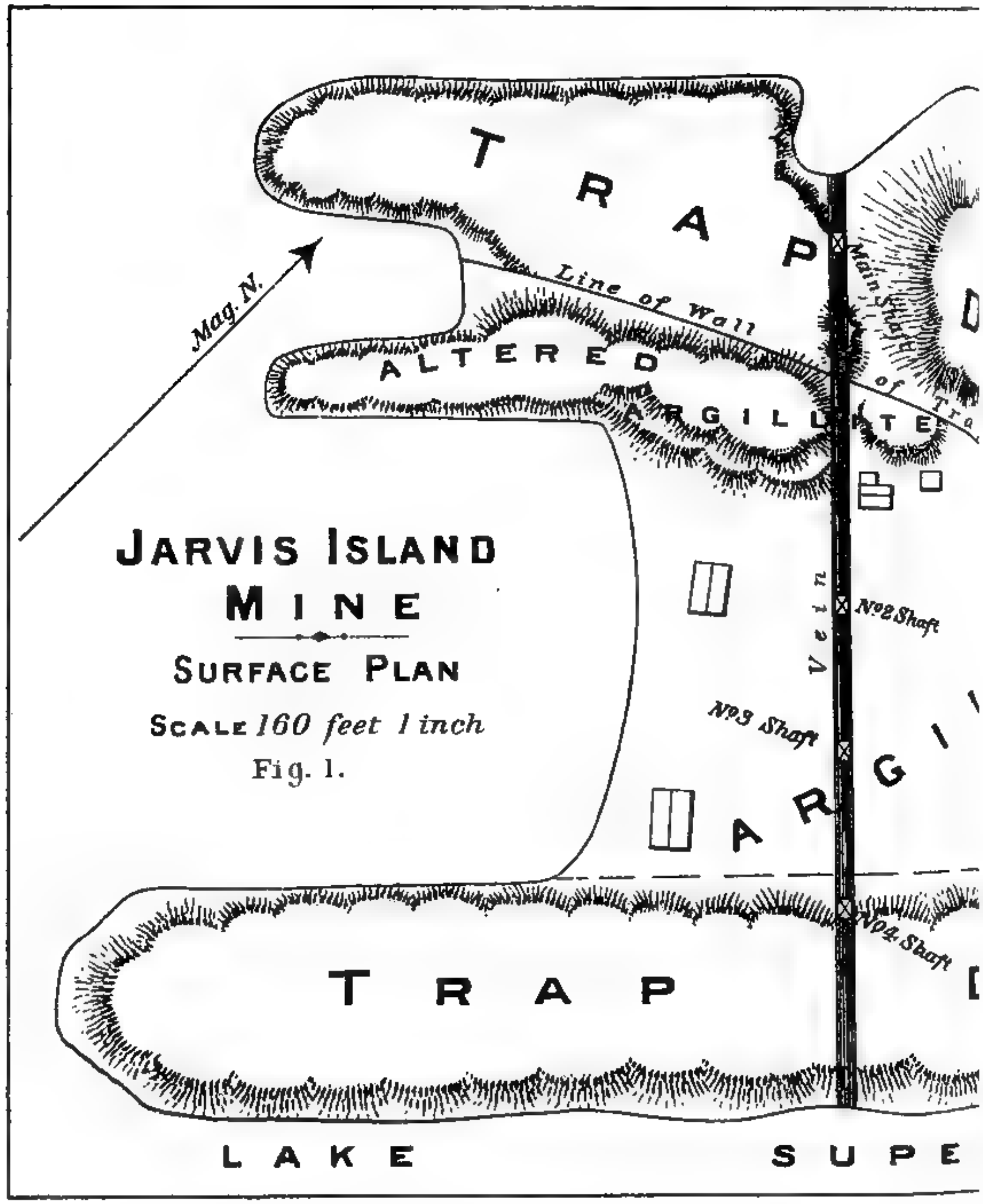
Vein characteristics.

1st. About four feet of largely crystallized calcite, with thin seamings of quartz throughout, occurring mostly between the crystals and along their cleavage planes.

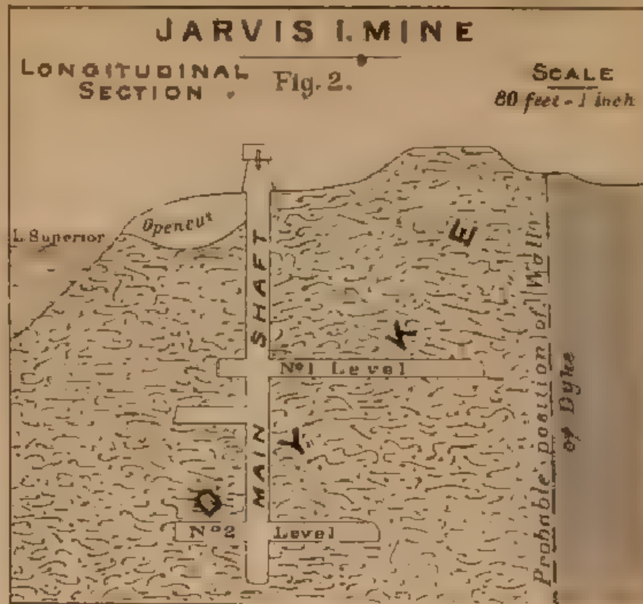
2nd. A two foot band in which the calcite still preponderates, but with a large admixture of barite and a small per-centage of quartz seams as before.

3rd. About six feet consisting almost entirely of barite, with only a few inclusions of calcite.

The same banded structure is visible in the main shaft, where there is, however, a good deal of decomposed rock enclosed, and slickensided walls would indicate fissuring and movement subsequent to filling. Although silver ore has been found from time to time in the vein, the bodies have apparently been so far of limited extent.



From Sketch survey made by E. D. INGALL, M. E.



From data supplied by Mr. J. Trethewey, 15th Aug., 1888.

EXPLANATION.

Trap.

Argillite.

The other metallic minerals, as elsewhere, occur concentrated in spots in the vein, and occasionally carry a little silver, as evidenced in the assay of a specimen which came from the lower drift whilst I was there. (See Report of Progress, 1887, Part T, Assay No. 34). It contained about 2 per cent. of blende and galena, with a little pyrrhotite, and gave: Gold, none, silver, 0·35 of an ounce to the ton of 2,000 lbs. An assay of some of the pyrites from this vein showed it to contain neither gold nor silver. (See Report of Progress, 1886, Part T, Assay No. 20). This vein is somewhat analogous to the Silver Islet vein in carrying carbonaceous matter, which shows as a black seam on the hanging wall. Assays.

Victoria Island and McKellar's Point.

Passing westwards along the band of dykes forming the "Macfarlane Belt," we come to Victoria Island. This is similar to the rest, having several dykes of trap running through its length, with intermediate argillites, which latter however, here compose a much larger proportion of the island than is the case with those just mentioned. The developments made are situate at its western extremity, where a vein of the usual type, of barite and calcite, running in a north-westerly direction, has been tested by surface work and by two test pits to a depth of thirty feet. Some tunnelling was also done on another vein. It is said that about $5,000 were expended on this island. Geological structure. Veins.

At this end of the island there is a large development of a red syenitic rock. Whether this is a product of the alteration of the argillites by the intrusive rocks of the dykes, or what is the precise nature of the causes which originated this rock, must be left in abeyance for closer study, both on the ground and with the aid of the microscope. Red syenitic rock.

On the further extension westward of this belt, at the extremity of McKellar's Point, very similar conditions are found. Here also there is a large development of the red syenitic rock in connection with trap dykes of the usual basic nature and dark appearance. The syenitic rock varies in different places from a highly crystallized, rather coarse-grained red rock, showing distinctly to the eye the red felspar associated with the green, apparently hornblendic, mineral, while in other places, whilst presenting the same general color and appearance as the typical syenite, it is much finer grained, and has more the appearance of a clastic rock which has been somewhat metamorphosed. Here also nothing can be definitely said of the origin of these rocks without further work being done.* This syenitic rock has a distinctly McKellar's Point.

* See Appendix, Specimen No. 85.

bedded appearance at this point, showing a dip to the east at about 15°. Another curious feature here presented, and which is noticeable also in the rock at the west end of Victoria Island, consists in the occurrence of inclusions, which have the appearance of bent and twisted pieces of argillite which have been metamorphosed.

These rocks only occur at the extremity of the point, the rest of which consists of a regular tangle of dykes of trap of the ordinary nature, with argillites included between them, the whole forming a prominent rocky ridge running back towards the mainland. Numerous veins of the usual nature cross the point in a more or less north-westerly direction. They carry a little of the ordinary metallic minerals of the district in a gangue of barite and calcite, with some colorless and amethystine quartz. A little work has been done on some of them, notably on one on the north side of the point, on which an 80 foot tunnel has been run in and a shaft about 30 feet deep sunk.

Veins on McKellar's Point.

Coast Section.

Red syenitic rock at Little Trout Bay.

The north shore of Little Trout Bay presents very similar phenomena to those just mentioned. Here we find quite a large development of this red rock, which at this point, however, has a much more distinctly syenitic composition and appearance, in marked contrast to the general appearance, structure and mineral nature of the other igneous rocks of this formation. It lies apparently in beds, interstratified with the usual sedimentary rocks. Several of these occur here, with varying thicknesses of argillite between, which latter in places thins out so as to leave two syenitic beds in direct contact, the plane of division between the two being, however, still quite distinct.

Examined by eye, this red rock seems to consist largely of red felspar, with which a green mineral is intermixed, probably hornblende or an alteration product of that mineral. It is for the most part moderately coarse-grained, and in places is porphyritic from the presence of large felspar crystals distributed throughout the rock and occurring occasionally in large nests or aggregates in a dark hornblendic base. Dykes of the ordinary dark-green basic traps cut these beds in places.

Intrusive trap sheets at Caldwell Pt.

On the eastern side of Caldwell Point occurs a little bay whose northern shores consist of cliffs about thirty feet high, coming down vertically into the water and which present a very good section, showing intrusive trap sheets in the flat lying argillities occurring similarly to those noticed at Spar Island. They show the same features, viz :—Flat under and arched upper surfaces closely conforming to the bedding planes of the enclosing argillities. Two distinct sheets are distinguishable,

the upper one at one place having protruded a tongue from its lower surface and lifted a part of the sedimentary rock on which it lies, which is now visible as a thin sheet of shale, projecting upwards into the mass of the trap and making an angle of about 19°, with a horizontal bedding of the rest of the beds. Passing eastwards along the section, the upper surface of this upper trap sheet is seen to curve downwards to the water level, and at its eastern end to be overlaid by the argillites resting on its remarkably flat, smooth upper surface, which here shows the end view of the columnar structure of the sheet. Another trap sheet is seen to overlie these argillaceous beds about fifty feet above this point. A vertical trap dyke about the middle of the section cuts the horizontal traps, &c., causing a displacement of a few feet, thus being evidently younger than them. Other displacements have also occurred causing a slight difference of level of different parts of the beds.

Different ages of trap dykes, sheets, etc.

At the extremity of the same point the surface of a similar trap sheet shows slightly above water, and is intersected by a small dyke of trap closely resembling it, but which, judging from its well defined walls, is evidently younger. Similar evidences of differences of age are occasionally observable with the dykes, notably at one point, on the shore about north of McKellar's Point where a larger dyke is cut by a smaller one, running on about the same course. The former consists of moderately fine grained greenish gray trap, showing distinctly the radiately arranged felspar crystals upon the weathered surface and decomposing into a loose granular mass, whilst the smaller and younger dyke has a much more compact structure, rendering the separate minerals indistinguishable, and weathers to a smooth, uniform, rusty-red surface.

Rocks of coast section N. from Caldwell Pt.

Passing northwards from this point the rocks are well exposed in a series of hills, with cliff faces, running parallel to and close to the coast. These vary from 200 to 400 ft. in height, and consist of the sedimentary beds of the series capped by coarse trap, giving them the table-topped appearance so characteristic of the district. The trap shows a thickness of from 50 to 100 ft, and has a very characteristic vertically columnar structure. This rock also appears in the shape of numerous dykes, cutting the sedimentary beds, and forming nearly all the points along the coast, owing to their superior power of resisting denudation agencies. These dykes consist for the most part of dark colored compact trap, and have often, a columnar structure at right angles to their walls. They are often left standing up like walls, and although they are frequently visible running up to the sheets of traps capping the hills, it could not be positively said in any instance whether they cut through them or not, and although in several cases they appeared

Traps.

to do so as viewed from the water, it was either found impossible to reach the spot at which this might have been proved, or when reached, the covering on the rocks prevented the necessary observations from being made. A good instance of this is observable on the north side of Turtle Point a little west of its extremity where a dyke of a very compact trap, and with a marked columnar structure, normal to its walls, rises out of the water as a perpendicular cliff, owing to the removal of all the argillite originally enclosing it on the lake side. This dyke is seen to extend as high as the top of the trap sheet capping the argillites on its inner side, and seems to retain its horizontal columnar structure to the top, even where in contact with the vertical columns of the horizontal trap.

Effects of trap dykes on sedimentary beds.

These dykes, curiously enough, have in nearly every case altered adjacent rocks very slightly or not at all, and in most instances the impress of the bedding of the argillities can be seen on the sides of the dyke where they have been stripped bare. Occasionally the argillite may be porcelanized for a distance of one or two inches away from the dyke, but this is the exception, and an instance was never encountered where a crystalline structure was induced in them. This contrasts strongly with the large amount of alteration observable near the Jarvis Island and Spar Island dykes already mentioned, and which was also observed near the dyke forming the western point at the entrance of Cloud Bay, where red felspar crystals were noticed to occur in the argillite, immediately adjacent to the dyke. This absence of alteration is also noticeable with regard to the contact of the horizontal sheets of trap where there is occasionally a slight amount of induration of the underlying sedimentary beds, a few inches below the junction, but generally there is no appreciable effect of this sort. The line of division between the two rocks, both in this district, and where studied elsewhere in the formation is generally quite distinct, and where the softer underlying shales, etc., have been removed by weathering, which is very frequently the case, the lower surface of the trap is presented as a smooth overhanging plane. Occasionally, where not assisted by this weathering effect, there is a little difficulty in locating the exact plane of the junction which is rendered more difficult sometimes by the frequently very fine grain of the trap close to the contact and its close resemblance to the colour and grain of the fracture of some of the underlying sedimentary beds. As a rule the thicker trap sheets found capping the hills get coarser in grain towards the top, but with the less extensive and thinner beds occurring at other horizons, no such effect is noticeable, and neither these latter nor the dykes show that coarser grain towards their centre which one would expect.

Effects of trap sheets on sedimentary beds.

Varying texture of traps

As a rule, the trap in both these last instances is a much finer grained, darker colored and more compact rock than the first-mentioned.

Sedimentary deposits.

The sedimentary beds of the coast section consist of what may generally be termed argillites, although, from the preponderance of silica, they merge in some places into sandstone and in others take on more the nature of dolomites or limestone, from the large development of carbonates. They vary in color from a dark to a light bluish-grey, and in structure they vary also from flags to shales, according to the extent to which the bedded structure is present. Other noticeable features are the occasional presence of a little mica along the bedding planes and a confused ropy structure of the surface of some of the beds, resembling somewhat ripple-mark in some instances, whilst in others it gives one more the impression of the surface which would result from the flow of a viscous mass or thick mud beneath a surface skin.

Jointing of same.

Wherever developed, the jointing shows two sets of planes, one bearing between east-north-east and north east and dipping from 65° to 85° southwards; the other bearing about north-north-west and dipping from 80° to 85° westwards. It is noticeable that these two strike directions closely correspond with the two main systems of fissures in this vicinity—the north-easterly dyke and the north-westerly vein systems.

Dip of formation.

These sedimentary beds all along the coast are found lying comparatively flat, and although locally they dip slightly, and these dips are at times in somewhat contradictory directions, yet they may possibly have a general dip in a southerly direction of a few degrees. The difficulty of determining the general dip of the whole formation is enhanced by the existence of numerous shallow synclinals and anticlinals and shallow basins in the beds, and by the local disturbances and contortions due to faults and dykes, although the latter only produce these effects occasionally.

Several veins have been located along this Coast Section, and a little work done at the following places:—

Stewart's Location (Near Pigeon River).

Coast group of veins continued

This is one of the tracts of land originally taken up by the *Montreal Mining Company* in 1846, and is now owned by the *Ontario Mineral Lands Company*. In 1868 a small party of men explored there for about a month without result. Later on, the *Silver Islet Company* had a party working for about a year on several north and south veins carrying copper glance.

Pine Bay.

Coast group of veins continued.

A little has been done here on a N. N. W. vein carrying argentiferous galena, but the proportion of silver was not large.

Big Trout Bay.

Near the inner end of this bay some test work has been done on a vein running in a north-westerly direction, and dipping to the north-east at an angle of 70° to 75°. It is about twelve inches thick, and has definite walls where seen in the workings. It cuts a hill about 300 feet high of argillites, capped, as usual, with trap, and intersected by dykes of the same rock. The work done is near the top of the hill, and shows a vein which, in the usual gangue of coarsely crystallized calcite and barite with a little amethystine quartz, carries iron pyrites and shows indications of copper in the shape of occasional malachite stains. Around the workings the country rock is entirely trap, which carries a large percentage of pyrites adjacent to the vein. A piece of this was selected for assay to see whether the pyrites carried the precious metals, which proved not to be the case. (See Part T, Annual Report Geological Survey, 1886, Assay No. 17).

The work done consists of some stripping on the back of the vein, and two tunnels, each about 50 feet in length, one 30 feet below the other, run on the course of the vein. It was done in the years 1882-83, and some $1,500 were spent on these developments.

Cloud Lake.

Here argentite and native silver are said to occur in a vein with blende and galena in quartz. An adit 200 to 300 feet long was driven into the side of the hill to cross-cut the vein, but did not succeed in finding it, as it had apparently split up. The surface explorations traced the vein for about a quarter of a mile, in which a good show of silver is said to have been seen. The expenditure on this work probably amounted to about $25,000. This vein was supposed to be the continuation of the last-mentioned one, but as the distance between the two points is about five miles, this is rather a gratuitous assumption.

Caldwell Island.

This island is composed almost entirely of trap, intersected by numerous dykes of the same. A shaft was here sunk to the depth of 60 feet on a vein, without much result.

Mink Island.

A wide vein, carrying some indications of copper in a gangue of calcite and barite, crosses the dyke forming this island. In 1872-3 a slight amount of work was done here, and some little was accomplished on the mainland opposite, which showed a promising looking vein. The expenditure amounted to about $1,000. Coast group of veins continued.

Sturgeon Bay. (*K.* 13.)

Some capitalists of London, Ont., did some work here. Two large veins occurring in the argillites near a dyke were seen intersecting under water near the shore. A shaft was sunk close to the water's edge, on the north shore of the mouth of the bay, and a drift run out to cut the veins at their junction. A shaft was also sunk some 300 feet further inland.

K. 17 *Location.*

Some test work has been done on a brecciated vein consisting of the argillite country rock cemented together by quartz. It runs north 60° to 70° E. (mag), and dips to the south 80°. It is said a strong force of men worked here for nearly a year about 1878 or 1879, and that the expenditure at this time amounted to some $5,000.

Prince's Mine.

This is the oldest mine on the Canadian shores of the Lake, having been worked in 1846 or 1847, when it appears to have been regarded more in the light of a copper than of a silver-bearing vein. It strikes N. 30° to 40° W (mag)., and where it shows on the shore is split into two branches, with argillite between and trap forming the outer walls—that on the eastern side appearing to be a dyke cut transversely by the vein. Regarding the trap on the western wall, it is not very apparent whether it is a large dyke also traversed by the vein, but it shows as a forty-foot cliff rising out of the water, running south from the vein exposure mentioned for a distance of fifteen chains, whilst inland it shows as a similar wall running about parallel to the vein and dipping about 80° to the S.W., up against which almost horizontal argillites are seen to abut. About sixty yards in from the shore, at a point where the two before-mentioned branches would seem to come together, a 65 feet cross-cut tunnel has been run through the argillites in a westerly direction towards this cliff, the inner end of which tunnel intersects numerous branches for a distance of about twenty- Enclosing rocks.

Coast group of veins continued.

five feet. The vein next shows about 250 yards further inland, where it outcrops on a hill, at which place two shafts have been sunk on it and a tunnel has been driven in on it towards the shafts about fifty feet lower than the mouth of the higher shaft. The vein down to this level occurs in trap, but whether this is the bed which caps the argillites in the neighborhood, or whether it is the extension of one of the dykes that are seen on the coast further north, running in this direction, it would be impossible to ascertain without making a much closer examination than I found it possible to do with the time at my disposal. The drift being blocked up with debris, it was impossible to enter; but it is said that a winze was sunk some fifty to sixty feet below this, and whether the vein was thus followed down into the argillites, or what was the effect of this change of the "country" rock, it would be interesting to know, but it is now impossible to find out after this lapse of time. According to the Geology of Canada, 1863, this tunnel was driven for a distance of 163 feet, and one of the shafts was ninety feet deep, in sinking which a bunch of ore was obtained weighing several hundredweight and containing three per cent of silver, which in two assays yielded respectively one part of gold in 7,000 of silver, and eight parts to 1,000 of silver. This bunch contained "native silver disseminated in thin laminæ through the calcareous spar and blende.........Crystallised sulphuret of silver was also found in this vein, and the calcareous spar was stained with blue and green carbonates of copper and with red arseniate of cobalt."

Rich silver ore.

Between these workings and the shore exposure the vein must intersect several trap dykes which are to be seen along the coast to the north, striking in such a direction as to there run athwart it.

Vein characteristics.

The two branches on the shore are respectively five and six feet thick, whilst at the inland workings, where it exists as one vein, it is much thicker. It here shows a central rib of coarsely crystallised calcite with some barite, with a large proportion of largely crystallised, mostly amethystine, quartz on either side. Judging from the loose ore on the dump, blende seems to have been the most plentiful metallic mineral in the vein at this place.

On the shore exposure the vein presents very similar characteristics, except that the metallic minerals do not seem to have been so plentiful and that some of the branches consist almost entirely of quartz, whilst in others calcite and barite mixed constitute the greater part of the vein stone.

Assays.

Assays made of specimens selected on account of the metallic minerals present in them, proved these to carry neither gold nor silver. (See Report of Progress, 1886, Part T, Assays 21 and 22.)

Pie Island.

This island consists of the usual argillaceous series of sedimentary beds traversed in a north-easterly and south-westerly direction by dykes of trap, the same rock capping the argillites in the table-topped hills. Coast group of veins continued.

The developments shown in Fig. 1, Plate II, were made on one of the north-west series of veins which occurs on the western shore of this island. The underground developments have been made in the vein where it cuts a trap dyke, which intersects the argillites of the vicinity, or immediately adjacent to it. The width of the vein is from three to four feet and is filled with a breccia of fragments of the country rock cemented together by crystallised quartz, which is mostly colourless but sometimes anethystine, and is accompanied by a little calcite, which occurs mostly crystallised in scalenohedra in the vugs. The great feature of this vein, as shown by an inspection of the dumps, consists in the large amount of metallic minerals it carries. These are blende, galena and iron pyrites, mentioned here in the order of their preponderance, and all occurring for the most part well crystallized, especially in the case of the galena, of which small but very perfect crystals of a combination of $\infty P \infty$ with O may be found. This latter also occurs sometimes as thin seams in the joints of the argillite, which, on account of their dark, lustreless appearance, might possibly be mistaken for argentite by the inexperienced, especially where the films are thin. An assay of such a piece showed it to carry neither gold nor silver. (See Report of Progress, 1885, Part T, Assay 28.) That these metallic minerals, although they are occasionally found to do so, as a rule carry either none of the precious metals or a very small proportion, is shown by the other assays given in the same place. Assay 25 of a specimen selected as carrying a good proportion of galena, free from other metallic minerals, gave: Gold, none; silver, 0.175 of an ounce to the ton. The other numbers: 26 carrying a good proportion of blende mixed with a little galena and 27 consisting nearly altogether of pyrites, gave neither gold nor silver. Developments. Vein characteristics. Assays.

The nature and extent of the developments made is shown sufficiently in the figure and needs no further description. Operations were conducted here about the years 1875-7.

Some development work has also been done on a large vein on 13 B mining location, about a mile E. S. E. from the last mentioned. It strikes in from the shore with a course N. 75° W (mag.), and dips to the N. It is about twelve feet thick, is enclosed in the argillites of the district and intersects two trap dykes which cut through them. 13 *B.* Mining location.

13 B Vein. A shaft has been sunk on it, the depth of which was not ascertainable, however, as it was full of water. In mineral contents it is very similar to the first mentioned, except that the quartz is accompanied by a good proportion of pink spar, probably dolomite.

Assays. One assay made of some specimens selected as carrying some galena and a little blende, gave neither gold nor silver; whilst another sample, broken from an outcrop about half a mile from the latter point and about on the run of this vein, which carried some galena accompanied by a little pyrites, yielded on assay: Gold, none; silver, 0.467 of an ounce per 2,000 lb. ton. (See Report of Progress, 1886, Part T, Assays 29 and 30.) Little or no work has been done on the rest of this island.

The Port Arthur Group.

The Port Arthur group of veins. The members of this group of silver veins may be considered in two sub-divisons:

Div. I.—In which the veins occur in the Animikie rocks.

Div. II.—Comprising those occurring in the Archean area to the north of tne former.

Division I.

General conditions. This comprises most of the veins of this group. They occur in the lower beds of the Animikie which consist for the most part of siliceous rocks, cherts, silicified argillites, etc., with a small development of the softer and carbonaceous argillites. The chief developments have been made on veins near the northern fringe of this formation, whose thickness must be here comparatively slight, owing to its practically horizontal position, and the way the old Pre-Cambrian surface dips under it. This was actually found to be the case at the Shuniah mine, where as hereafter mentioned, the vein was followed through it and into the underlying older rocks.

Thunder Bay Mine.

The discovery of this vein by Mr. Peter McKellar in the fall of 1866, may be said to have been the commencement of the second era of mining activity in the Thunder Bay region. As it was not found possible to visit this place, the following description has been compiled from various sources.

Vein characteristics. This vein strikes N. 34 E. and dips at a high angle to the north-west and consists of a series of "closely reticulated veins of white granular quartz the largest being about one inch thick and the aggregate aver-

aging perhaps ten feet. It carries native silver and argentite, accompanied by galena, blende and iron pyrites." According to Mr. McKellar "the ore occurs in bunches three to eighteen inches thick by six to forty feet in length, the silver being in strings, leaves, grains, etc., irregularly distributed through the vein-stone which constituted the greater part of the bunch. At the first opening there were two of the streaks, one next to the north or hanging wall, and one in the middle. It is not well defined, being generally in ribs with considerable slate between" (F). Mr. McKellar further states that the vein was strong and rich in the upper strata but below consisted of small stringers with galena, etc., but little silver.

Port Arthur group of veins—continued.

Dr. Bell, in his description of the mine, points out that "silver often forms ten per cent. of the mass" (H), in the isolated bunches of ore occurring in the vein, and says further that the country rock consists of a thick bed of trap underlaid by from fifteen to twenty feet of "alternating beds of dark shale, impure dolomite, argillite and what appear to be diorite layers. These are followed in descending order by massive dark olive and drab-grey argillaceous slate, about fifty-five feet of which have been cut in the shafts." (H.)

Enclosing rocks.

The work done consists of four shafts sunk on the vein, a cross-cut driven north-west at the ten fathom level, and some drifting, done between the two deepest shafts. No. 1 shaft is some seventy feet deep, No. 2 is the same depth and 300 feet north-east of it, whilst 150 feet further on is another shaft thirty-five feet deep, and again 150 feet to the north-east on the strike of the vein another shaft has been sunk to the depth of twenty-five feet. Ore was stoped out from the outcrop of the vein between the two extreme shafts over a distance of 600 feet. On surface the vein was traced upwards of half a mile, and besides the erection of necessary buildings, three miles of a good waggon road were constructed to the shore of Thunder Bay, where a stamp mill was erected as well as a dock 200 feet long, built of crib work filled with stone. Work was stopped in the spring of 1869.*

Work done.

According to Mr. Robb (Report on the Mineral Statistics of Canada, Geo. Survey, 1871-2) the product of the mine was 3,294 lbs. of ore, worth $2,592.

Expenditure and results

The work was done by an English company having a capital of $400,000 divided into 80,000 shares of the value of $5 each, 60,000 of which were unassessable, thus leaving a working capital of $100,000.

The mine was again opened up in 1874, and Mr. Peter McKellar, in a letter to myself, recently received, says: "The *Thunder Bay Mine* was in operation on this occasion for six months or more....The mining was almost entirely done on the south spar vein with no success. The spar

Mine re-opened.

* "The *Thunder Bay Silver Mine* ..... has not been worked since the winter of 18.9-70." (I).

Port Arthur group of veins—continued.

vein is large, six to twelve feet wide, bearing E.N.E. & W.S.W. with a high angle of dip to the south, whilst the silver bearing vein, the one from which all the silver was taken, is a parallel vein about twenty feet to the north, one to three feet wide, principally quartz, and dipping at a high angle to the north. The south vein seems to be the main fissure occupying a line of fault, the other a dropper from it. The mining on the spar vein was carried on through a cross-cut at the ten fathom level from the foot of No. 2 or B shaft." He further states that some 200 tons of low grade ore from the first works of the mine had been hauled to the company's mill, but not treated, and that after the closing down of the mine the last time, the manager hauled it to his own mill (five head of stamps) at Port Arthur and milled it, of the results of which Mr. McKellar speaks as follows: "Having seen the work in operation I have no hesitation in stating that it yielded well, the concentrates, which were sold in the States, were unusually rich in fine native silver. The actual yield was not made known."

The Shuniah or Duncan Mine.

Vein characteristics

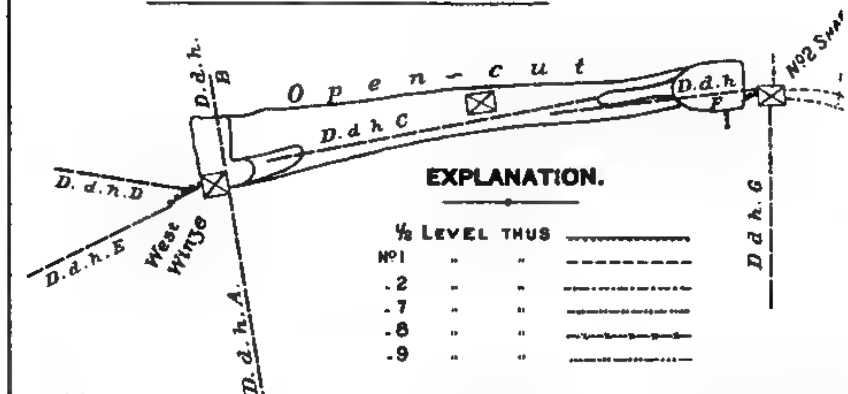
The vein strikes nearly E. and W. and has a general dip to the south at a high angle from the horizontal. The total width on surface is twenty to thirty feet. According to Prof. Chapman who reported on the mine in August, 1868, "Several cross lodes intersect or run into the Champion vein. These are at present altogethe rundeveloped, but they show on the surface a gangue of quartz holding small quantities of galena, blende and pyrites......These cross veins appear to have an average breadth of six or seven feet, and......are well defined." Several of these were afterwards intersected in driving cross-cut "a." (See Plate V, fig. 2), and were found to dip northwards.

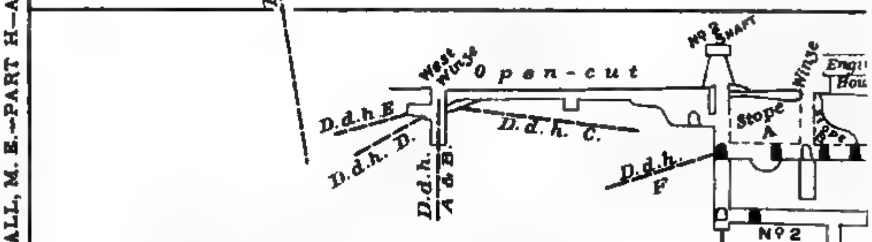
Mr. W. M. Courtis, who was manager of this mine for some time, gives the following description of it: "The vein consists of one main fissure, with many parallel fissures rising from the foot wall" (or south wall) "at different depths, and at some places striking into the main fissure afterwards continuing as separate fissures again. These small fissures seem to be the silver bearing part of the vein and the large fissure is silver bearing only in the neighborhood of these junctions.... The ore is in bunches with ground almost barren between......The vein contains horses of the country rock......The edges of the fissures are often brecciated carrying native silver or ore, as do also many of the black slate *horses* in the main vein, deposited on the surface of the slate" (B). "We find these *horses* from the size of a pin to masses weighing tons. The effect of the solution" (which filled the vein) "upon them was silicifying. The extremely fusible green slate, equally with

MINES AND MINING ON LAKE SUPERIOR, BY E.D. INGALL, M. E.—PART H—ANNUAL REPORT 1888.

Fig. 2.

HORIZONTAL PROJECTION





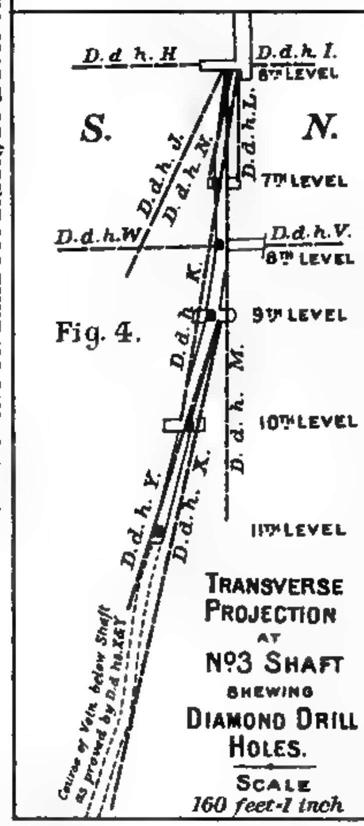


Fig. 4.

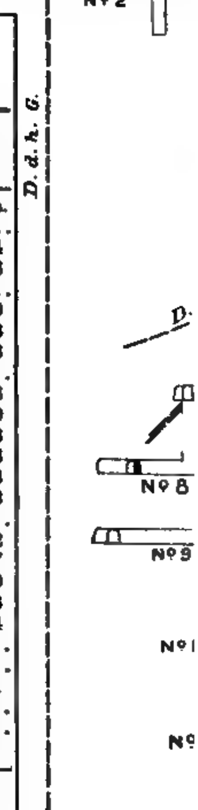
TRANSVERSE PROJECTION AT Nº3 SHAFT SHEWING DIAMOND DRILL HOLES.

SCALE 160 feet-1 inch

TABLE OF DIAMOND DRILL HOLES.

Hole.	Angle of Inclination to the Horizon. °	′	Length. Feet.	Ins.
A	10	....	152	....
B	67	45	99	4
C	7	50	144	8
D	29	....	65	....
E	14	50	66	10
F	17	06	89	8
G	88	08	685	8
H	Horizon	tal.	103	....
I	Dit	to.	50	6
J	65	....	189	10
K	81	....	299	8
L	90	....	90	8
M	90	....	372	8
N	78	45	90	8
O	13	50	67	....
P	20	50	110	2
Q	41	....	120	7
R	20	50	161	10
S	45	....	192	8
T	45	....	185	4
U	Horizon	tal.	91	....
V	Dit	to.	65	....
W	Dit	to.	123	11
X	....	....	418	....
Y	....	....	250	....

Total length of Holes, 4,283′ 7″



Compiled by E. D. Ingall, M. E., from tracings and plans supplied by Mr. W. M. Courtis, M. E., and

ISTORY SURVEY OF CANADA.

., LL. D., F. R. S., DIRECTOR.

Plate V.

upplied by Mr. W Rapsey.

Desbarats, Lith.

the black slate or felsite horses, retained its sharp edges. They all analysed much higher in silica than the adjoining country even though embedded in a mass of spar" (G).

Port Arthur group of veins—continued.

"The principal gangue, almost all *the* gangue, is calc-spar. The lime sometimes is replaced by magnesia or manganese. At *Duncan*, there is no pink spar" (as at *Silver Islet*) "but it is coloured amethyst, and cavities near the surface are filled with black oxide of manganese...... Quartz is the second mineral in importance in the gangue" (B). He also says in a later publication that some of the vugs, as at *Silver Islet*, "contained hydrocarbon gas under great pressure" (G).

Gas.

Enclosing rocks

The accompanying cross-section (Plate VI, fig. I) through No 3 shaft, shows the enclosing rocks of the vein at that point as worked out by Mr. Courtis from knowledge gained in the opening up of the mine, and from careful records kept by himself of the numerous diamond drill holes bored. The dislocation produced by the vein is very apparent. The trap sheet "A" shown overlies the rocks for an area of several square miles to the south. Owing to the trend of the vein bringing it nearer to the trap bluff in passing westward, and to the fact that the strata have a south-westerly dip—the trap forms the south wall of the vein almost down to the first level at No. 2 shaft, and to the half level at the west winze, being at these places opposed to the black slate of the north wall, the line of contact sloping upwards on the south side to the surface at No. 3 shaft as shown in the cross-section.

The rocks marked L, H & K in the figure may be said generally to belong to the Archean, as distinguished from the horizontal Animikie rocks lying on them, but whether they can be properly considered as the equivalent of the rocks which have been called Huronian in that district, and found to be gold-bearing, it is not possible to decide from an inspection of the eight specimens of drill cores kindly lent me by Mr. Courtis, for whilst one of the cores has all the appearance of coming from one of the green mottled dioritic beds which are very typical of the gold-bearing formation of the district, yet the rest of the cores seem to be more related to the gneissic rocks of the Laurentian. Mr. Sargent, who was in charge after Mr. Courtis, in writing to the latter gentleman seems to have noticed a great difference in these Archean rocks on either side of the vein, for in speaking of the drill cores got in boring north and south from the vein, he says, "The rocks on the south are unmistakeable diorite, whilst on the north they are felsite, hornblende and (syenite ?)"

The Animikie rocks in the section would seem to have all the characteristics of the lower beds of this series as exposed elsewhere in the district, viz., a great preponderance of dolomitic and cherty rocks with

Port Arthur group of veins —continued.

silicified argillite and small occasional developments of the soft carbonnaceous black argillites. Mr. Courtis says, "The silver seems to give out as soon as the leaders enter the dolomite." (B.)

As the cross-section given in Plate VI, fig. 1, would be incomplete without fuller descriptions of the rocks, I quote those given in Mr. Courtis' paper from which the illustration has been copied. (Transactions American Institute Mining Engineers, vol. XV, page 671).

"The microscopic determinations, made by Mr. John Caswell, of slides I had cut from some of the cores, are given below; but I should preface them with the remark that Mr. Caswell wrote me he had had very little time, and felt a great lack of confidence in describing these specimens, as the rocks were new to him. He added the names simply as suggestions, needing confirmation after more extended study."

Descriptions of the different rocks enclosing the vein are then given as follows:—

"A, on the section, is probably an olivine gabbro of Dr. Irving, but has been called diorite: sp. gr., 3.033; proportion insoluble in acid, 83.4 per cent.; silica, 54.2 per cent.; proportion attracted by magnet, 2.8 per cent.

"B, a black slate, containing less carbon than E: sp. gr., 2.640; proportion insoluble in acid, 91.5 per cent.; silica, 74 per cent.

"C, may be said to be a dolomite with chert, and G, a chert with dolomite and pyrite.

"D, is a dark-green slate, with masses of chert, red above and gray at the base of this formation. It very easily fuses to a black glass which is magnetic. Different specimens gave the following results:—

Sp. Gr.	Insol.	Silica.	
2.528	33.9 per cent.	31.5 per cent.	
2.776	61.2 "	48.3 "	
2.654	84.4 "	84.0 "	(chert).
3.225	19.0 "	17.7 "	18.9 per cent. loss on ignition.

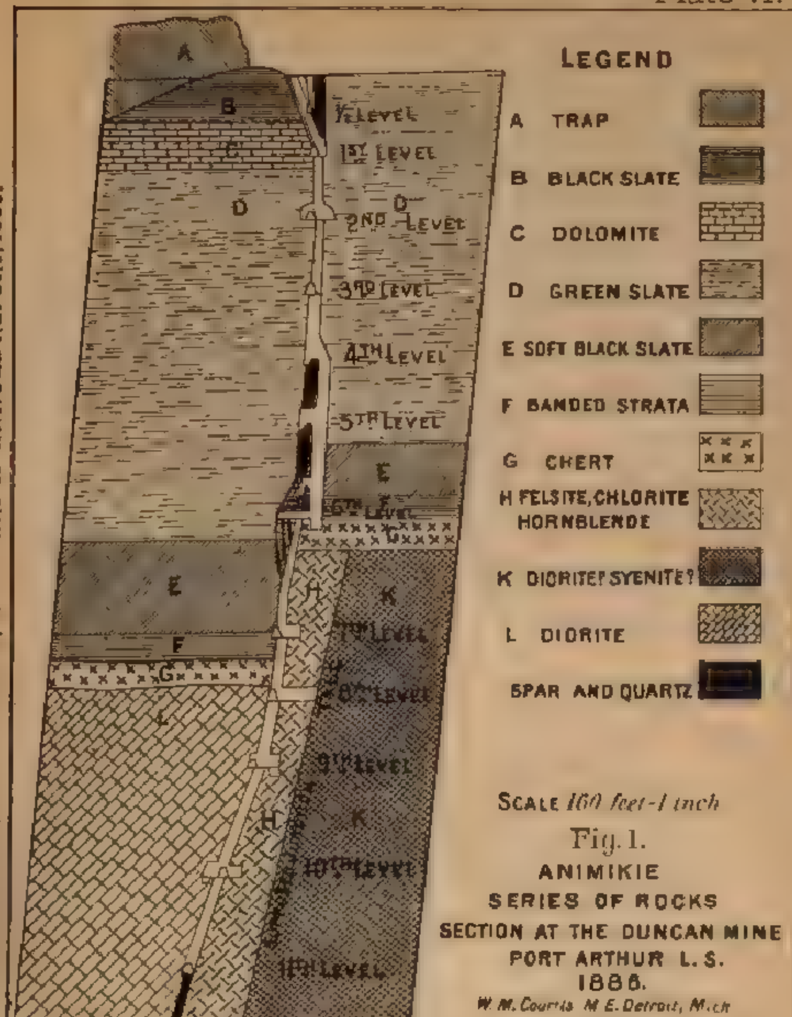
"E, is a soft, carbonaceous black slate, with shining particles, and apparently obliterated fossil stems. Sp. gr. 2.531; insoluble, 83.9 per cent.; silica, 54.2 per cent.

"F, was composed of three bands:

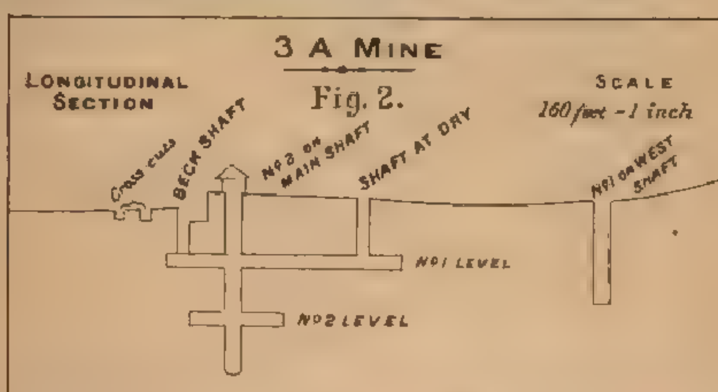
1. Calcareous band (green) containing much iron. Sp. gr., 2.765; insoluble, 43.4 per cent.; silica, 34.7 per cent.
2. Arenaceous band (green), in flinty black slate. Sp. gr., 2.488; insoluble, 78.8 per cent.; silica, 53.6 per cent.
3. Jasperized slate. Sp. gr., 2.627; insoluble, 92.6 per cent.; silica, 85.7 per cent.

"G is chert mostly, with some dolomite.

Plate VI.



From a paper by Mr. W. M. COURTIS, vol. xv, Trans. American Inst., Mining Engineers.



From a drawing given in Mr. P. McKELLAR's Pamphlet on "Mining on the North Shore L. Superior," 1874.

"This band is so tough, that a party of excellent Cornish miners made, on contract, but five feet per month for two months in sinking an inclined shaft. On one seam, the diamond drill worked for eight hours, using up a bit, and took out but six inches of core, drilling about one foot in that time.

Port Arthur group of veins —continued.

"Mr. Caswell describes a section of the quartz thus: 'Fine-grained, with some faint, skeleton-like crystals of augite scattered through it. Their character could not be determined exactly.'

"'Dolomite, dark-colored, effervescing in warm acid, with remains of fibrous diallage or hornblende, partly altered to serpentine mass. Quartz grains are scattered through it.'

"The vein seems to have been shattered at this point to thousands of stringers spreading through thirty to forty feet. Above, the vein was six to eight feet of solid gangue; below, as far as sunk on it, the foot-wall seemed perfect, to which these stringers were coming in from the south. These stringers carried in this belt much galena and zinc-blende, but not give above nine ounces in silver for highest assay.

Sp. gr.	Insol.	Silica.
2.713	32.8	32.8 Olive-green dolomite.
3.023	69.8	69.8
2.738	55.0	55.0

"H, seems to be a belt of much broken-up rock, parts of it much altered, probably from the effect of the vein. Sometimes the drill would be in a solid red felsite, then in solid hornblende, then in talcose or chloritic seams, or the rock would take the form of a diorite for some feet, and then go back into solid hornblende.

Sp. gr.	Insol.	Silica.	
2.962 per cent.	32.8 per cent.	29.5 per cent.	Hornblende.
2.830 "	59.1 "	46.5 "	Mixed.
2.624 "	93.4 "	71.0 "	Felsite.

"As we entered the body of solid rock marked K, the drill-hole, being vertical, passed farther away from the vein, the rock became fine-grained, and increased in silica, mica replacing the hornblende to some extent. Sometimes there would be pretty large crystals of orthoclase. In certain parts, without any sign of vein-stringers, there would be amygdules of calcspar, various specimens of core giving up from 6 to 25.5 per cent. in acetic acid. The most calcareous had a specific gravity of 2.703; insol., 55.6 per cent.; silica, 42 per cent.; loss on ignition, 5.3 per cent.; in acetic acid, 25.5 per cent. Nothing was taken up with the magnet, but there was more or less pyrite in the mass.

Port Arthur group of veins—continued.

"K, is described from Mr. Caswell's sections, except the part carrying the most mica:—

Sp. gr.	Insol.	Silica.	Appearance.
2.737	89.1	64.0	Syenitic.
2.651	84.6	70.5	Syenitic, Granitic.
2.655	86.0	78.0	Porphyritic.
2.773	70.8	56.5	Dioritic.
2.980	83.2	44.9	Hornblendic.

"The core at 650 feet from the surface showed:—

1. Plagioclase, much altered and very dusty, but with banding still visible.
2. Quartz, in pellucid masses and grains, with some large and many small fluid inclusions with moving bubbles. The fluid cavities in the quartz are very pretty.
3. Hornblende, much altered, with greenish veins running through it; pale green color, and only slightly polarizing.
4. Apatite. The rock is much altered, and is probably of the same family as at 800 feet and 809 feet (diorite?).

"Core at 800 feet from surface (diorite? hornblende schist?):—

1. Hornblende, in green crystals, showing cleavage-lines of 124° and dichroism very distinctly. In some places altering slowly to brown biotite.
2. Orthoclase, cloudy and irregular in color, showing cleavage-lines. It may be plagioclase, a point which can only be decided by angle of absorption.
3. Quartz, pellucid grains, abundant between hornblende crystals.
4. Apatite, abundant in colorless crystals.
5. Plagioclase, faintly banded between crossed nicols.

"Core at 809 feet (diorite?):—

1. Plagioclase, much decomposed, but distinctly banded.
2. Orthoclase, some cloudy crystals.
3. Hornblende, the same as at 800 feet, but more altered.
4. Apatite, in colorless needles, and some large white crystals.

"L, wherever penetrated, seemed to be a typical diorite—was at least so called by every one seeing it, though it has not been yet determined microscopically. Specific gravity, 2.869; insol., 69.8 per cent.; silica, 5.7 per cent.

"I am indebted to Mr. Caswell for the determination of the slides, as a friendly matter for my private information.

"The rocks marked H and K crop out about 14 miles to the north of

the mine, and have been called metamorphic Huronian by geologists describing this section. They present the same appearance as the cores, a brecciated, wavy mixture of hornblendic, felsitic and granular patches." (G.) Port Arthur group of veins —continued.

Occurrence of ore bodies.

The silver in the vein was, as shown, all found above the first level, where the upper bed of black argillite formed one wall of the vein. And Mr. Courtis, writing me, says the best ore in the mine was obtained from near the engine-house winze, near the letter "A" in stope "A" (See Plate V., fig. 1). He says:—"In sinking this winze, which was at the junction of a spur going south-east from the main vein, we took out $3,500 in rich specimens, and supposed it denoted a large body, but the stope extended but a few feet each side and ran into poor ground, whereas we expected a block of rich ground from No. 2 shaft to the Sulphide Cut." He goes on to say that at this point there were stringers running parallel to the vein in the south wall, and that "the main vein was barren. The stringers carried more or less silver, which made in bunches of ore worth $1 a pound. From "A" (See Plate V., fig. 1) "we took out about $1,500 in one blast; two inches above it, trap made the walls and *horses* in the vein, and no more silver was found. The stringers pinched out both east and west."

History of mine and work done.

The history of this mine, as gleaned from Mr. Peter McKellar's statements, seems to have been somewhat as follows:—

The vein was discovered in 1867. During the summer of that year and the following winter, trenching was done on the back of the lode at several places, and two shafts were sunk, one to a depth of thirty or forty feet and the other to a depth of sixty feet from the surface. From the bottom of the latter a cross-cut was driven across the lode. At first, silver was got in small bunches in the form of leaves and fine strings penetrating quartz, spar, blende and galena, in a streak of those minerals running along within two feet of the south wall. In sinking, it was lost at a depth of about eighteen feet, but found again in the middle of the vein in the cross-cut at the sixty feet level. Several barrels of ore were taken out, reported to have run from $200 to $300 per ton. The mine was then closed, owing to a disagreement between the owners and to want of funds, which led to a chancery suit, so that altogether, including expenditure thus incurred, some $25,000 to $35,000 were spent.

The mine was opened again in 1870, when it was bought for some $75,000. The main shaft was sunk to a depth of 135 feet, drifts were driven on the lode at the first and second levels, and cross-cuts at several places. One of these latter was driven south for 100 feet, in

Port Arthur group of veins—continued.

expectation of cutting another lode. A good many thousand dollars were spent in further tracing the vein on the surface, and they then began to follow up the silver in the drifts, and a few days after, orders were given to shut down, so the mine was again closed in the middle of the summer of 1873. The results of this work were that they failed to find any lode in the cross-cut south. They got silver at several points in the drift, and took out a barrel or two of very rich ore a few days before closing. The vein was found to continue large all the way down, the hanging wall only being seen in the cross-cuts.

In November, 1873, it was again started under the name of the *Duncan Mine*, having formerly been called the *Shuniah*. There were several reports of silver having been struck at various places, but Mr. Courtis says:—"All the reports that the *Duncan* had struck silver below seventy feet were false.......In January, 1877, however, plumbago was struck at a depth of 315 feet." (B.) He further says:—"The richest ore has assayed, in bulk, 2,020 ounces, the poorest concentrations seventy-three ounces, and as about sixty tons of rock are concentrated into one, the original stamp rock is often pretty poor. In some parts, especially near the surface, the stamp rock has assayed six to eight ounces, taking out the whole rock for six to twelve feet wide. These rich places also give some hundreds of pounds of very rich ore.......The very rich argentiferous zinc blende is found only at the surface. Although large quantities of zinc blende are found below seventy feet, it contains only a trace of silver." (B.)

Occurrence of ore.

Prof. Chapman, in speaking of this surface blende in the before-mentioned report, says:—"The yellow blende holds in most samples a small amount of silver. Some fragments of this blende gave me also in one assay a trace of gold corresponding to about two penny-weights in the ton."

Developments in lower part of mine and results.

Regarding the developments in the lower part of the mine, it would seem that after sinking into the Archæan, no silver was found to any extent, although the vein still carried the other metallic minerals, which, whilst nearly always free from silver, or very poor in it, occasionally assayed high. The vein was much smaller and less solid than at the surface, with numerous branches coming in on the hanging wall, whilst quartz replaced the spar gangue found above, the spar being only found in a few stringers and filling vugs. In boring the diamond drill hole "U," sludge assays were got, giving from $110 to $2,500; and Mr. Sargent, speaking of this point in writing to Mr. Courtis, says:—"A diamond drill hole was bored from the shaft east, ninety-one feet, and meeting with good sludge assays for quite a distance, and one small speck of native silver being found, a drift was

run in that direction, but was discontinued at ninety feet, as the vein had pinched to a thread, and only a few specks of silver had been found in a small seam in talcose slates on the south. Some little native silver was found in the shaft from twenty feet above the level to fifteen feet below; in every instance as a thin coating on the felsite breccia, and not in the quartz. The vein was pretty well filled with felsite horses." Port Arthur group of veins—continued.

The mine closed finally in the fall of 1881, having been worked almost continually since its discovery in 1867, although with very varying vigor, the force varying from two men to one hundred. Mine closed.

Besides other surface work a mill of ten head of stamps with four Frue vanners was built at the mine, and operated for a couple of months. Mill.

According to Mr. Courtis, the total product of the mine amounted to about $20,000 worth of ore, whilst the total outlay, including cost of property amounted to about $500,000. Expenditure and returns.

Besides those shown in the illustration, Plate V, I find there were other drill holes bored, viz.: Horizontally, N. and S. from the 11th level; one W. from the end of the 9th level, and one near No. 2 shaft, the latter to seek for silver in the lode between the 6th and 7th levels, amounting in all to about 600 feet, which added to those shown on Plate V, makes a total length of holes bored of about 4,884 feet. Diamond Drill Holes.

Dr. Selwyn in visiting the mine in August, 1872, found development work in progress on the vein on the adjacent property to the west of the west winze. This consisted of three test pits, respectively fifteen, thirty-four and twenty feet deep, placed equi-distant, and testing a length of vein of some 600 feet beyond the west winze.

The Beck, or Silver Harbour Mine.

This mine has been opened on a vein running E. N. E., and dipping at a high angle to the N. W. It has a brecciated character and is about five feet thick. The gangue consists mostly of white granular quartz, but barite, calcite, fluor and amethyst are also present with much iron pyrites, galena and blende. The silver occurs mostly as argentite, but also in the native state. The country rock is here much the same as at the *Thunder Bay Mine*, and consists of smoke colored cherts and dark argillaceous shales, running nearly horizontally under what appears to be a bed of coarsely crystalline trap. The junction of the Animikie and the Huronian lies about half a mile to the north of the mine. Vein Characteristics. Enclosing rocks.

This vein was discovered in the summer of 1870, and during the winter of 1870–1, a force of about fifteen men worked on it, who did History and results.

Port Arthur group of veins—continued.

some surface exploration, built three or four houses and sank a forty foot shaft. Work on the shaft was then suspended and developments made on the vein in the surface bed. In the winter of 1871-2, a new manager took charge who continued the workings in the surface bed. A number of good buildings were erected and a dock built, at which the largest steamers could lie. Work was stopped in the fall of 1872.

Ore obtained.

"The vein showed a considerable quantity of silver in the upper siliceous and dolomitic bed, but towards the bottom of the shaft in the argillaceous beds it was irregular and poor" (F). Mr. Courtis states that 125 barrels of ore were shipped, reported to be worth $300 per barrel, but proved only to assay $17 to the ton (B). Mr. McKellar who saw this ore in the barrels before it was shipped, accounts for its low yield thus: "No wonder by the way it was assorted......the greater part of it was very poor, although some was good." (F.)

The company working this property paid $10,000 in cash for it and guaranteed to spend $100,000 in developments.

It has not been found possible to obtain any plans, etc., of the underground workings of this mine, and as it was found impossible to personally visit it, the above description has been necessarily compiled from the writings and statements of others, chiefly from those of Mr. Peter McKellar in his paper on Mining on the North Shore of Lake Superior.

Algoma Mine (Macgregor Township).

This must not be confounded with the mine of the same name in the township of Neebing.

According to Dr. Selwyn, who visited this place in August, 1872, this vein strikes about E. N. E. He makes the following remarks on the phenomena there observable. It is "half a mile east of Silver Harbour, and similarly situated at the base of a diorite bluff, fifty to sixty feet high. Here they have sunk through about thirty feet of soil or clay before striking the rock which is the usual cherty banded shale traversed by a brecciated vein of quartz, calc-spar and rock fragments, holding galena and pyrites in nests and small aggregations of crystals. The shaft is at present only twenty feet deep. Captain Talon stated that in another shaft sunk on the run of the vein to the eastward, they had driven towards the diorite bluff and struck it, cutting the flat shales like a wall, but that there was no indication of a vein at the junction. This would show that many of these diorite bluffs are dykes and not interposed beds."

Lambert Island.

This island consists of trap and on it some $500 were expended in 1884, in testing a vein of rose colored quartz with fluor spar. The vein strikes about N. W., and is from eighteen inches to three feet thick. A shaft was sunk on it, but did not penetrate the trap to the argillites supposed by the owners to underlie it.

Port Arthur group of veins continued.

Cariboo Island.

Some surface exploration has been done on veins in the Animikie rocks here, but with little or no result.

Blende Lake.

Two or three test shafts have been sunk on a vein carrying argentiferous galena, said to run $14 to the ton in silver. It cuts the Animikie rocks of the vicinity.

Singleton Mine.

This is the name given to a small opening made on a vein of granular white quartz about one foot thick, from which some rich bunches of native silver were obtained. It is situated within the town limits of Port Arthur in the Animikie rocks of that locality.

Walbridge Mine.

This is in the north-west corner of the township of Neebing, and according to Mr. Peter McKellar's descriptions, it would seem that the vein worked here ran nearly E. and W. and dipped at a high angle to the south. It has a width of some twenty-four feet and is well defined. It carries galena, blende, copper and iron pyrites in bunches, stringers and disseminated in grains through a gangue of calcite and quartz. The *country* consists of the siliceous and argillaceous beds constituting the lower division of the Animikie rocks of the district. In 1863, the property was bought for $1,200 or $1,400 from the original owners, by Detroit capitalists, who kept a party of six to seven men at work on it during the summer and following winter. Some trenching was done on the back of the lode at various places, and a forty foot shaft was sunk on the copper-bearing part of the lode. The miners said there was a two to three inch streak of ore in the bottom of the shaft, and the vein increased in richness in depth. They also got some good shows of galena in some of the open cuts on surface and traced the vein for a considerable distance. The developments were made with a view to selling the mine, but not having been successful in this, no more work was done (F).

Port Arthur group of veins continued.

Dr. Bell, in his report on this district made in 1870, also describes the following veins as occurring in this vicinity:—

Algoma Mine.

This is on the adjacent lot to the last. "Three veins, one of them thirty-one feet in width, and holding galena, occur here." There is an outcrop of a highly ferruginous sandstone, giving on analysis about 37 per cent. of metallic iron.

*Paresseux Rapids.**

A ten to twenty-five feet vein shows here, crossing the river in an E. N. E. direction. In a gangue of barite, calcite, quartz and fluorite, it carries a little galena, blende, copper and iron pyrites.

Lots 4 and 5 Paipoonge.

On the north bank of the Kaministiquia river, a vein three to four feet thick occurs running north eastward. It contains a little copper pyrites, iron pyrites and galena in a gangue of barite, quartz, calcite and fluorite.

Mining Lot M. (McIntyre Township).

On this lot is a large barren vein, having a total width of forty feet, coursing N. 50° E. and dipping to the S. E. at 80° from the horizon. It has a coarsely brecciated character, much of it consisting of a net-work of small veins of quartz with a little calcite. It cuts the arenaceous beds, and dark slates all weathering to a dark iron black.

Mining Lot C. (McIntyre Township).

A vein carrying copper pyrites cuts the same ferruginous sandstones mentioned as occurring at the *Algoma Mine.*

DIVISION II.

Silver veins in Archean rocks.

The members of this group are still silver-bearing, but occur as said in the rocks of the Archean age, and from the data obtainable, apparently in that sub-division known as the Huronian system.

The three A. Mine.

Vein characteristics.

This vein strikes N. 75° E, and dips slightly away from the vertical. It has a thickness of from eighteen inches to two and a half feet. The gangue is mostly quartz with a little calcite, "through which are

irregularly distributed the ores of iron, copper, lead, zinc, nickel and silver, with some cobalt and gold as shown by the assays. The silver is found native and combined with sulphur and nickel, thickly penetrating the vein stone in small and large patches, in some of which it is very heavy" (F.) The ore is stated to have been as rich as much of that at Silver Islet. One sample of the ore is said to have assayed 1.4 per cent. of cobalt, and 25 per cent. of nickel. Port Arthur group of veins continued.

The enclosing Huronian rocks here consist of grey dolomitic schists, associated with dark green compact diorite, whilst dark greyish red, felsitic syenite occurs a short distance to the south. The dip of the strata is nearly vertical. Enclosing rocks.

The discovery of this vein was made in the winter of 1869 and 1870. A considerable amount of work was done on it. The accompanying sketch plan and section of the mine up to March, 1874, taken from Mr. McKellar's paper on Mining on the North Shore of Lake Superior shows the underground work. (See Plate VI, fig. 2). On surface the vein has been traced over half a mile. During the winter of 1871-2 two miners worked on the lode and took out twenty-two barrels of ore. Towards the fall of 1872, the sinking of the shaft was begun and the work of development carried on for some time. The silver seems to have lasted down but to have been pocketty. I have been unable to ascertain when operations were discontinued, but Mr. Courtis, writing in February, 1877, speaks of the mine as closed, He also says that the value of the ore obtained was probably about $2,000. Work done and results.

Near three A.

Mr. Courtis mentions the discovery of a two feet vein of milky quartz in the vicinity of the last mentioned mine, carrying native bismuth and yielding on assay a little silver. It was traced for some distance, and a few shallow pits were put down on it. (B.) Bismuth.

Cornish Mine.

Active operations were commenced on veins at this place in the spring of 1873, and continued for about a year, but apparently without any satisfactory result. The veins strike about east and west, and are said to be in the Huronian, and to carry much blende, galena and iron pyrites.

Emmons' Mine.

This mine is situated on Lot A in the township of McIntyre on the Dawson road, about five miles from Port Arthur. Dr. Selwyn, who visited it in 1872, describes it thus: "The 'mine' consists of one pit

The Port Arthur group of veins concluded.

twenty feet deep, full of water, sunk on a thick vein of white calc-spar mixed with quartz, often showing amethystine colours, and both traversed by thin strings and cubic crystals of galena, also spots of mispickel and iron sulphurets, and more rarely, copper pyrites. The rock is a hard, white-weathering silico-felspathic gneiss, sometime epidotic and dioritic, probably Huronian.

Dawson Mine.

The same authority also mentions the occurrence of a vein at this point on a property known as R 2, about three and a half miles up the Dawson road from Port Arthur. It strikes about E. N. E. and, is in hard cherty silico-felspathic rocks, probably near the junction of the Huronian and Animikie rocks.

RABBIT MOUNTAIN GROUP.

The Rabbit Mountain group of veins.

Mr. Oliver Daunais, a trapper and explorer, besides his many other discoveries, located the first vein in this district at the spot where the *Rabbit Mountain Mine* now is, having had it pointed out to him by an old Indian. The great richness of the ore found there caused the revival of interest in the Silver Mining of Thunder Bay, and the commencement of the present era of activity, the inauguration of which has been largely due to the hopeful and energetic initiative of Mr. T. A. Keefer, of Port Arthur

Conditions of [redacted]

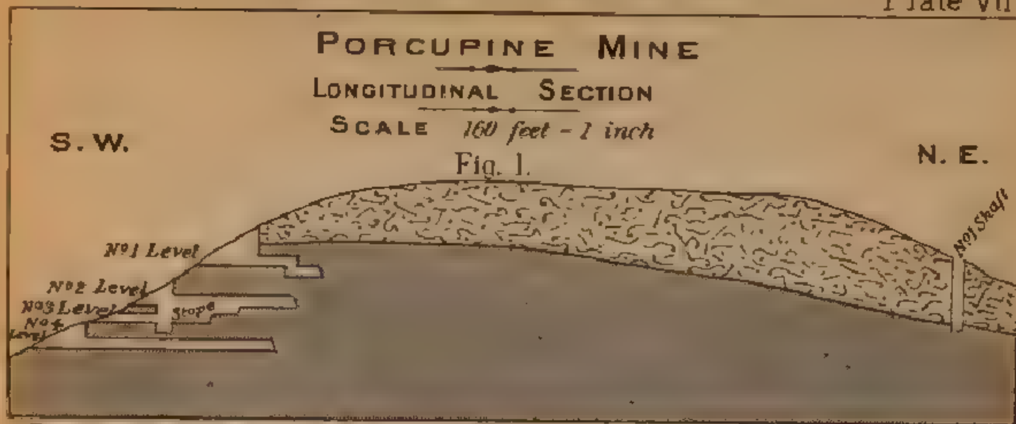
The conditions of occurrence of this group are somewhat different to these of the others situated on this line of discoveries in being further removed from the northern boundary of the formation, and from the outcrop of the lower siliceous division. They are all in the upper argillaceous division with its associated trap sheets, the argillites here being soft and black, and showing little or none of that silicification and mergence at places into the cherty rocks which characterises these beds at some other places. In a preliminary examination of the rocks of the vicinity, no developments of chert were found even in the lower levels. These rocks show, however, at the *Victoria Mine* at a point about three miles north-east from the *Beaver Mine*, alongside the road from that place to Murillo, at a level of about 350 feet below the adit of the latter mine so that the downward extension of the argillaceous beds in this district must be considerable.

Rabbit Mountain Mine.

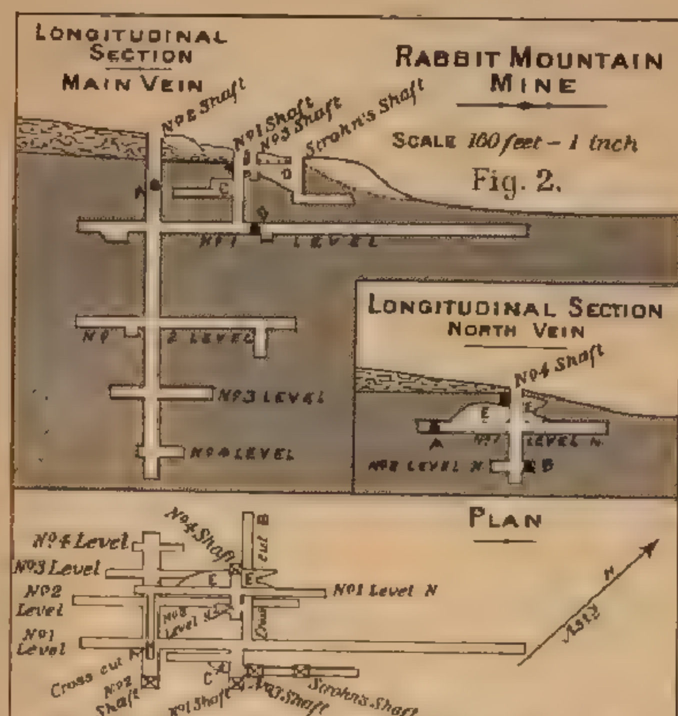
Vein characteristics.

This vein strikes N. 35°-45° E., and dips at an angle of about 65° to 70° to the N. W. The vein is a composite one, consisting of a number of branches and stringers interlaced, and is about four to six feet in thickness, although much wider in places. The ore

Plate VII.



From Sketch survey made by E. D. INGALL, M. E.



From plans and data supplied by Mr. W. C. MCCOMBER.

EXPLANATION.

TRAP. ARGILLITE. CROSS-CUTS.

consists of native silver and argentite, accompanied in considerable quantity by blende with a little iron pyrites and galena, and occasionally copper pyrites in a gangue composed of quartz, calcite and green and purple fluorite. The accompanying plan and section will show the amount of work done to test the vein. (See Plate VII, fig. 2). A good show of rich ore was obtained on surface and caused great excitement in the district. On surface, the vein has been proved for a length of some 800 feet to the south-west, by two trenches and cross-cuts into the side of the ridge along which the vein runs. It is thus exposed at two places, one of which is 500 and the other 800 feet from the main shaft. At the first point the vein shows four feet thick, but the cut was not through the vein. No mineral was visible there. In the second cut a similar quartz vein showed, but it carries a little galena, calcite and green and amethystine fluorite. The vein was in the trap at this place.

The Rabbit Mountain group of veins continued.

As will be seen by a reference to the illustration, the lithological environment of the vein is similar to that of many of those already mentioned, and the developments have been made, as at those places, following the vein downwards through the trap sheet, which it intersects at the surface, into the dark colored, soft argillites below. On either side of the valley, in the bottom of which the vein has been worked, are high bluffs, showing horizontal argillites, capped again by the usual vertically columnar sheet of trap from 80 to 100 feet thick, whose contact with the supporting argillites is, on the south side of the valley, about 150 feet above the mouth of No. 2 shaft. Whether the lower trap sheet at the mine represents a portion of the upper one, brought down into its present position by faults, it is impossible to say without a much more detailed study of the ground than time allowed to be made, but it seems more likely that the trap at the mine is a separate sheet occurring lower in the formation.

Enclosing rocks.

South-west of the mine a small dyke of compact basic trap is seen to cut the argillites in the before mentioned cliff and runs up into the capping sheet of trap. It strikes about N. W., or in such a direction as to cross the vein a little to the east of No. 2 shaft, and Capt. McComber states that they crossed it in the underground workings. It is only a small dyke and can be seen cutting the lower trap sheet near the shaft, whilst above in the cliff it has apparently faulted the strata, the bottom of the capping trap being 13 feet lower on the west than on the east side of the dyke. This would seem to show that the dyke is younger than either of the sheets of trap, although it cannot be very plainly seen on the ground that it cuts the upper one whilst beyond the fact that the dyke rock may be a little more compact than

Trap Dyke.

Rabbit Mountain group of veins continued. the upper part of the capping sheet, no mineralogical or structural difference between the two is discernible by the eye, and they both appear to be compact basic traps. The argillite immediately below the upper capping trap appears to be somewhat indurated, and is paler in color than the argillites of the vicinity.

Parallel veins. A parallel and similar vein to the last mentioned crops out about 100 feet north-west of the main vein, and dipping at a flat angle to the south-east would join the main vein a little below the No. 2 level. (See Plate VII, fig. 2, north vein.)

About 300 yards N. N. E. from No. 2 shaft and a little way beyond the mill, a vein is seen to outcrop in the base of the hill, forming the north side of the valley. It is similar in nature to the main vein, and about four feet thick, and appears to be parallel with it, both in strike and dip, and a blast put into the outcrop at this point whilst I was there showed some very good ore. The vein in this exposure has argillite for its southern or foot wall, which is opposed to the trap forming its hanging wall, which latter has either been faulted down by the vein from a higher position or is a dyke. In ascending the bluff rising to the north of this vein, the argillites are seen to occur above this again, whilst capping the whole, comes the columnar trap, which is apparently the equivalent of that on the other side of the valley.

Developments. Figure 2, Plate VII, shows the underground work done upon the vein up to the end of May, 1887. As shown, most of the ore taken out up to that date had come from depths of 100 feet below surface and under, where shown *stoped* out at "C," "D," and "E" in the figure, but good ore has been struck in other parts of the mine below this from time to time, and I myself saw some rich ore in No. 2 shaft at No. 2 level.

Stamp mill. A stamp mill with a capacity of fifteen tons per diem has been erected near the mine for the treatment of the low grade ore which is left after selecting out that which is rich enough to be barrelled up and sent direct to the smelters. Here the battery slimes are run over Frue vanners, and the concentrates thus taken out are sent to the smelters. Capt. McComber, who was the manager in 1886, claimed that these concentrates ran as high as $4,000 to the ton, and averaged $1,500. The slimes which pass over from the vanners are settled in tanks, and then amalgamated in pans. These slimes are said to average about 8 ounces of silver to the ton. The amalgam thus obtained is retorted in the usual manner to separate the mercury and the silver, and the latter is cast into bricks at the mine. Capt. McComber also stated that the milling ore was averaging $80 to the ton, whilst the tailings from the mill only show a content of about 1.5 oz. per

E. D. INGALL, PHOTO., 1886. IVES-PROCESS, G. E. DESBARATS & SON, MONTREAL.

RABBIT MOUNTAIN SILVER MINE.

LOOKING EAST.

The bluffs on either side consist of columnar trap, (diabase) capping the argillites in which the intervening valley has been eroded.

ton. The mill, however, proved to have been placed in rather an unfortunate position, as it had frequently to be stopped on account of scarcity of water supply.

Rabbit Mountain group of veins continued

Since its discovery in 1882, the work of testing this vein has been proceeded with in a very spasmodic manner, having changed hands several times and been worked with forces varying from two to sixty men. It stopped work recently on the 16th December, 1887. The accompanying view of this mine shows the bluffs spoken of and the position of the different buildings, etc. On the left hand side in the foreground is the shaft house over No. 2 shaft, with its dumps of ore and rock extending outwards from it, and the engine house showing just over the outer end of the nearest one. Over the top of the shaft house further away towards the north bluff is the mill building. All the rest are dwelling houses, etc.

History of mine.

View of mine.

Rabbit Mountain Mine, Jr.

This name has been given to the workings on a vein which crops out on the adjacent property to the last mentioned about 400 fteet N.W. from No. 2 shaft. It is about four to five feet thick, striking parallel with the *Rabbit Mountain* vein, and dipping towards it at an angle of about 75°. The vein-stone consists of calcite and white and amethystine quartz, with pale green fluorite, and carries blende, copper and iron pyrites. It outcrops in the same bed of trap which is seen at the *Rabbit Mountain Mine*, but owing to the ground rising about fifty feet from that point, the seventy-five feet shaft sunk on it had not at that time penetrated to the argillites below, which would probably account for the fact that the work done seems to have yielded little silver.

Porcupine Mine.

Here a fair amount of development work has been done on a vein which strikes about N. 65° E., dipping S.E about 75° to 80°, and has a thickness of from two to five feet. Its contents are similar to those usually found. The fluorite is coloured both green and amethystine, and the quartz often assumes the latter colour. A special mineralogical feature of this vein is the occurrence of the carbonate of barium or witherite, a specimen of which was analysed in the laboratory of the Survey by Mr. Hoffmann, who says "So far as I am aware this is the first time that this mineral has been met with in Canada" (See Report of Progress, 1885, page 29 M). The peculiar talcose material which occurs in some of these veins is also present here to a certain extent occurring in con-

Vein characteristics.

Witherite.

Talcose material.

Rabbit Mountain group of veins continued

nection with the ore bodies. It consists of a white or pale green material impregnating the vein stuff, which is quite soft and greasy when first taken out, but afterwards dries and hardens. The bulk of the silver occurs in the form of sulphide in nugget and leaf form, which is accompanied by a small proportion of metallic silver in wire and mossy form.

Enclosing rocks.

The enclosing rocks of the vein are as usual black argillites, capped on top of the hill with a sheet of dark compact diabasic trap. The faulting of these rocks by the vein has not been so great here as in some cases, only amounting to some 16 feet downthrow on the east side as seen in No. 1 shaft, which at the time of my last visit was down 57 feet, the junction of the argillite and trap being met with at 35 feet on the foot wall, and 51 feet on the hanging wall side. As shown in plate VII, fig. 1, nearly all the development works have been made in the vein where it cuts the argillites.

History.

This work was commenced in the spring of 1884, and has since been continued spasmodically with long intervals of inactivity, owing to the intention of the owners having been to simply prove the value of the vein with a view to sale, and not to work it. Mr. T. A. Keefer, one of the owners, states that about $10,000 had been expended on this vein to date, which expenditure had been more than repaid out of the proceeds of the sale of the ore obtained.

Beaver Mine.

Vein characteristics.

Two veins have been worked on in this mine. The main vein cuts in a northwesterly direction across a ridge about 200 feet high having a steep bluff face to the N.W., whilst it is intersected about 300 feet in from the face of the ridge by a cross vein running in a northeasterly direction or parallel to that face.

Cross-vein.

The cross fissure is very irregular and hard to follow, varying from a few inches in width to almost nothing. It was drifted on in No. 1 level for a short distance, and followed also on the adit level below for a distance of about 350 feet, but being very irregular, and only carrying a little mineral here and there, it was not considered profitable to follow it any further. The main vein has an average width of about four feet, although in parts of the mine it has pinched out to a mere thread. The contents are, as usual, yellow and dark coloured blende, with some iron pyrites and a little galena in a gangue consisting for the most part of calcite with some colourless and amethystine quartz, and a little fluorite which is generally green, but occasionally purple. The silver occurs in the ore

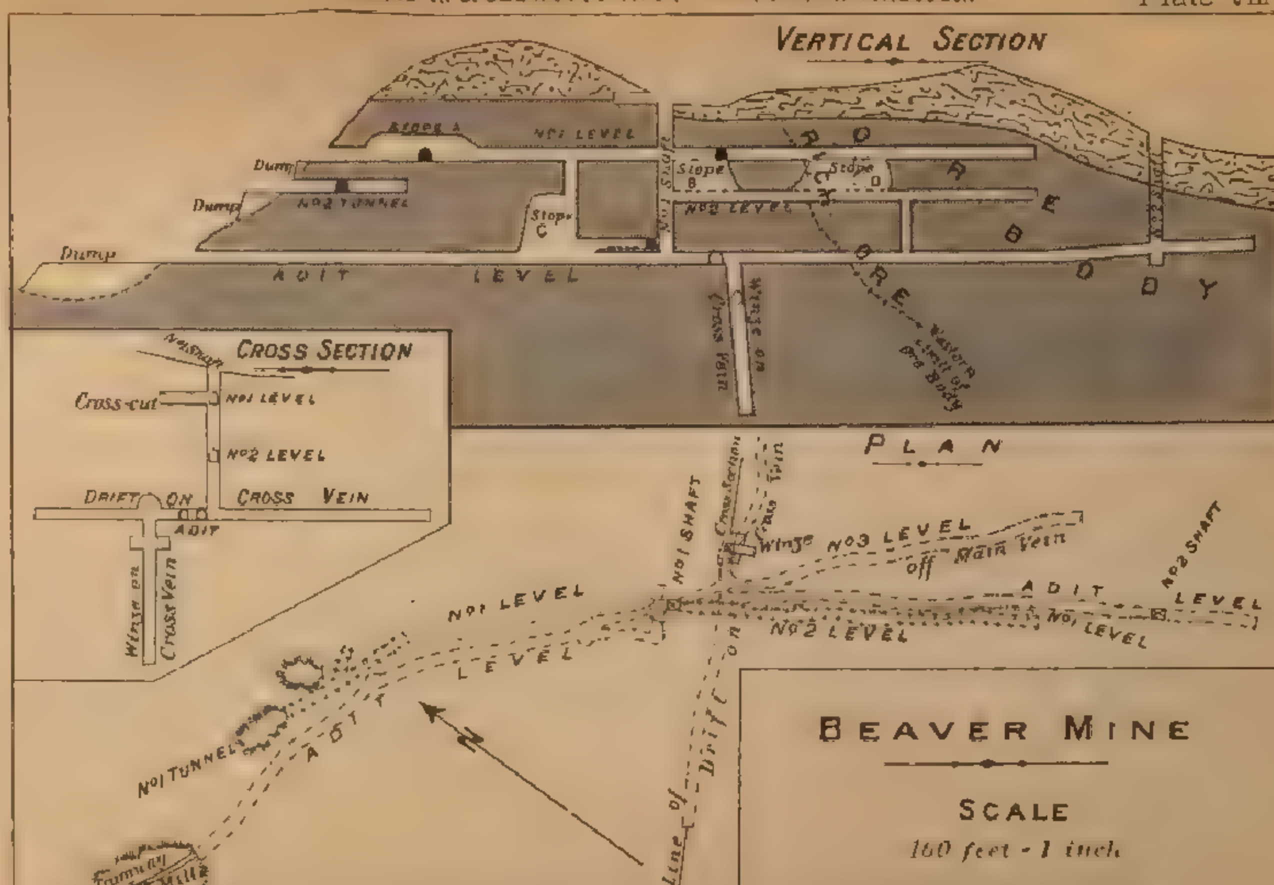
Silver ore.

bunches chiefly as argentite, in nugget, sheet and leaf form, with occasionally a little native silver. A marked peculiarity of this vein

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, C. M. G., LL. D., F. R. S., DIRECTOR.

Plate VIII



From measurements made by E. D. INGALL, M. E., Plans supplied by Mr. E. COSTE, M. E., and Section published by the *Thunder Bay Sentinel*.

MINES AND MINING ON LAKE SUPERIOR, BY E. D. INGALL, M. E.—PART H—ANNUAL REPORT, 1888.

EXPLANATION.

TRAP. ARGILLITE. CROSS-CUTS.

is the occurrence of the greasy talcose substance which is very abundant in the orey parts of the vein occurring in the fissures and cleavages of the gangue minerals, and surrounding pieces of argillite enclosed in the vein. It is very soft when first taken out, but hardens somewhat on exposure to the air. It occurs as white pearly films and incrustations, and also as pale green matter filling interstitial spaces. Some of this latter kind was examined qualitatively in the laboratory of the Survey, and Mr. Hoffmann says that the examination made showed it to be talcose in its nature, but that properly it was neither talc nor serpentine, as it was found to contain too much water for the latter. It is most likely closely allied to the mineral saponite, a hydrous magnesian silicate mentioned by Dana as occurring in the traps of this region. The ridge spoken of consists of black soft argillites from its base to within about fifty feet of the top from which point the rock is trap of the usual kind. The rocks have been faulted slightly by both veins.

Rabbit Mountain group of veins continued

Talcose material.

Enclosing rocks.

The work done in testing and opening up the vein is best appreciated by a reference to Plate VIII* which shows the developments to the spring of 1887.

Developments.

The history of this mine has been a very instructive example of what difficulties are to be met with in developing the veins of this district, and how they may be overcome by pluck and energy. The vein where first discovered on the brow of the hill, was solid and well defined, and where it passed down into the argillites below the trap, some good ore was obtained. In the drifts in the upper part of the mine it retained its definite characteristics, but in opening up upon it lower down in the adit level, considerable difficulty was experienced in following it, and it was found to be small and irregular, and for long distances was represented by a mere seam until the cross vein was reached and also for some distance on the other side of it. At the time of the last visit made drifts were being driven either way on the cross vein, with a view both to test it and also to cross-cut for the main vein to see if it had been by any chance left on either side in driving the adit level. This indefiniteness at this point seems to have resulted in the drifting of No. 3 level beyond the cross vein off the course of the main vein, as will be seen in the plan. Finding nothing but a small stringer in this direction, surveys were made, a course which should evidently have been adopted long before, and these having shewn what a very wrong direction the drift was taking to strike No. 2 shaft, where the vein showed definite and strong, a fresh start was made from the drift on the cross vein, and the adit level as well as Nos. 1 & 2 levels above, were driven forward to connect with No. 2 shaft, with the result that

History of mine.

* On this plate No. 1 Tunnel in Plan should be No. 2.

Rabbit Mountain group of veins continued

the vein was found to become strong and definite, and the body of very rich ore* was found which has made the prospects of the district look so much brighter. This vein was discovered shortly after that at Rabbit Mountain, and work was commenced on it by the owners to test it in the fall of 1884. This was continued with a small force of men until the sale of the mine to an American capitalist, who proceeded at once to equip it for work on a larger scale, and to open up the vein with most commendable vigour, with the results before mentioned.

Stamp mill.

A mill has been erected about half a mile from the mine, on Silver Creek, to treat the lower grade ore which occurs with the smelting grades. It has a capacity of about thirty tons per diem. The rock, after passing through the rock-breakers and two patent pulverizers,† is carried by the water over four Frue Vanners and a Golden Gate concentrator, whilst the slimes from these pass into settling tanks, the deposits from which pass to the amalgamating plant on the lower floor, which consists of two amalgamating pans and the accompanying settling pans.

Shipments of silver.

Some idea of the richness of the ore body mentioned may be gleaned from the following statements made by *The Algoma Miner and Weekly Herald* of August 27th, 1887, where it is stated that "the total value of the products of the Beaver mine for the past two and a half months in smelting ore and concentrates from the mill is $93,000. This may be relied upon as being authentic." There is every reason to believe this to be correct, as I am informed that the Customs export entries for Port Arthur showed that $190,000 of ore were exported during 1887, the greater part of which certainly came from this mine.

Silver Creek Mine.

Vein characteristics.

This is yet another vein in which silver has been found. It is from two to three feet thick, and strikes about N.E. in practically the same direction as the *Porcupine* vein, and for the slight depth to which it has been followed is about vertical. The preponderating mineral in the vein stuff seems to be calcite, which is accompanied by a little colorless quartz and some green fluorite. The unbroken part of the vein did not present much mineral to the eye, but the ore pile, which contained some eight tons, and had, I understand, come from the bottom of the shaft, where they get all their silver, contained the usual

* The value of the ore in sight in this body in the fall of 1887, has been variously estimated at from $1,500,000 to $3,000,000. The most reliable authorities, however, estimate it nearer the lower figure.

† I understand that since the date at which the mill was visited, stamps have been substituted for the patent pulverizers.

metallic minerals, viz., blende, both light and dark coloured, with some pyrites and a little galena, whilst the silver showed in the form of leaf and film argentite. Rabbit Mountain group of veins continued

The vein runs into a little ridge consisting of argillite capped with trap, which rocks have been faulted by the vein, the capping trap showing on the east side of the vein at the edge of the ridge, argillite being opposite to it on the other wall, the remainder of the trap sheet being most probably higher up on the other side, where the cover on top of the ridge prevents it from being seen. Enclosing rocks.

The test work done here has not been extensive, consisting of only a 75-foot tunnel driven into the base of the hill, on the course of the vein, at a depth of about fifteen feet below the bottom of the before mentioned trap, from the middle of which tunnel has been sunk a small test pit said to be 70 feet deep. This work was first prosecuted by the original owners, in the summer of 1885, who sold an interest shortly afterwards to the same American capitalist who owned the *Beaver Mine*. Under the new owners a little more work was done, with the result, as asserted by Mr. Crowe, under whose guidance it was done, that good ore was struck in the bottom of the shaft. The ore on the dump purporting to come from this point showed enough silver to class it as good mill rock. The energies and attention of the owners being required in the development of their other mine (the *Beaver*), work was discontinued on this vein until a more convenient season. Mr. T. A. Keefer, one of the owners, says that the total amount expended was about $3,000, and that the total value of the ores taken out, some of which was sold and some left in the dump, about covered this expenditure. Developments and results.

Little Pig Vein.

Through this property runs a high ridge, with a bluff facing north-west, a few chains from the base of which and parallel to it runs the Colonization road, connecting these mines with Port Arthur. A little way from its base and parallel to this bluff runs the vein which is known by this name, with a strike of N. 50° to 60° E. (mag.), and dipping about 70° to 80° to the S.E. It shows a thickness of six feet in some places, whilst in others it is split up so much as to leave the question of its thickness undeterminable. The vein-filling consists in places almost altogether of coarsely crystallized calcite, whilst at others a saccharine and crystallized white and amethystine quartz predominates, calcite playing a secondary part and being accompanied by a little purple fluorite, whilst the metallic minerals are represented by light coloured blende and galena. At places the vein is quite rusty from the decomposition of iron pyrites. Vein characteristics.

Rabbit Mountain group of veins continued.

The bluff consists of the usual dark colored argillites for 125 feet above its base, on top of which rests about 20 to 30 feet of columnar compact blue-grey trap, which sometimes carries a little iron pyrites.

The work done to test this vein to the end of 1886 consisted of three small tunnels driven into the base of the bluff to cross-cut the vein at about 40 feet below its out-crop on the side of the ridge. These are about 200 feet apart, and from their ends a small amount of drifting has been done on the vein amounting in all to about 60 feet. This work was commenced in 1885, but most of it was done after September, 1886, at a cost, it is said, of about $1,500

Elgin Vein.

About half a mile to the north of the *Beaver Mine* a vein has been located, named as above, which strikes about E.N.E. and dips at about 80° to the N.W. It consists of a number of parallel stringers distributed through a width of about ten feet of the enclosing argillite, which rock is capped by trap about thirty feet above the outcrop of the vein. The metallic minerals, which are very abundant and mostly crystallised, are represented by light and dark coloured blende, with galena and copper and iron pyrites in a gangue consisting mostly of white and amethystine quartz, with some dark purple, white, and light yellow-coloured fluorite and a little calcite. A 30 foot shaft represents the testing work done on the vein, which does not seem to have shown the presence of much rich ore, although the occurrence of silver in the other metallic minerals present, was demonstrated by an assay of some of that class of ore, which was made at the *Silver Mountain Mine* assay office, and gave $10 to the ton, as stated by the owner.

Other Veins.

Besides those already mentioned, many other similar veins have been located, upon which more or less test work has been done. The most important of these are known as follows: *R 48*, *Big Bear*, *Beaver Jr.*, *Badger*, *Rothwell*, *Peerless* and *Victoria*, all of which, with the exception of the first, are shown upon the Sketch Map.

R 48 is a vein cutting the east face of Rabbit Mountain about three-quarters of a mile north of the *Rabbit Mountain Mine*. On the *Big Bear* vein, which was located in 1886, a fair amount of development work has been done, and it is claimed that samples of ore obtained from the outcrop assayed from $8 to $124 per ton. The name of *Beaver Jr.*, has been given to a vein about one-quarter of a mile north of the

Beaver Mine. It is one of the south-easterly dipping series. The *Badger* is a south-easterly dipping vein on which test work is being done by American capitalists. On the *Peerless* vein, a small test shaft was sunk in the summer of 1886. The *Victoria* is the name given to a vein on which some little surface work has been done, which yielded vein stuff in which the metallic minerals were plentiful, but which at the points opened upon, does not seem to have yielded on assay more than a few dollars to the ton of ore. The veins at the two latter places are in a much lower horizon than the rest, being in the siliceous division underlying the black argillites. Rabbit Mountain group of veins concluded

The Silver Mountain Group.

This group received greater attention and closer study than the others with regard to the lithological environment of its veins, the details of which are represented in the accompanying contoured map of that district, which whilst, of course, specially illustrating the conditions of occurrence of this group, yet apply also in many particulars to the rest of the silver districts.

The rocks lying so nearly flat, it was deemed advisable, in constructing a map shewing this lithological environment, to contour it so that the vertical relationships of the different beds might be apparent at a glance. In a rough country such as this, and with the difficulties and delay consequent upon this roughness, this object could not of course be accomplished in any reasonable time with very great accuracy, and a method had to be adopted which would give reasonable results with the necessary rapidity. This was accomplished by levelling along the Colonisation road with an ordinary Y level, and leaving B.Ms. where it crossed the location and township lines. The profiles of the country were obtained over the rest of the area by levelling over the location and township lines with a hand-level and target staff, and connecting these as often as possible with the road B.Ms. when in calculating the results any discrepancies (which were not found to be very great) were distributed over the whole series in such a way as to be very slight at any one spot. The positions of the intersection of the contour planes with each profile having been worked out and transferred to the map, the contour lines were joined up in between points with the help of the general knowledge of the surface shape of the ground gained in the examination of the district. Method adopted in contouring map

The geological structure of the country, as worked out by the help of these levels, is shewn in the two sections given below the map, which speak for themselves. The upper one has been made nearly parallel to Vertical sections of map.

Stratigraphical relations of rocks of district.

the direction of the greatest dip of the formation as far as it can be determined, and shows the Animikie rocks resting in a nearly horizontal attitude on the Archean rocks to the north. Passing through Silver Mountain it shows the upper argillaceous division resting on the lower cherty division and overlaid by the sheet of trap forming the top of this hill, whilst the measured displacement of all these rocks by the two chief veins intersecting the hill, is also apparent. The lower section is approximately parallel to the line of strike of the silver-bearing rocks, and shows the different levels of some of the principal trap sheets of the district. Assuming that there has been no faulting of the measures, other than those visible and measureable ones produced by most of the veins, this difference of level along a section practically parallel to the line of strike, must represent actual differences of geological position, and as in the study of the other parts of the Animikie area, such undoubted cases have been frequently found of trap sheets occurring at various geological horizons in these rocks, not to refer to the local evidences to be mentioned later on, it was not considered reasonable to assume the existence of a number of dislocations of considerable extent to account for these differences of level, of the existence of which dislocations no other evidences could be found.

Trap at different levels in formation.

Correlation of different trap exposures.

Whilst it is therefore apparent that many of these different exposures represent individual and separate sheets of trap at various geological horizons, the correlation of some of the trap areas with each other seems reasonably possible. Thus, Table Hill and Wedge Hill areas are probably simply outlying patches of the sheet that caps the argillites of Brulé Hill, this sheet lying above the Palisades sheet, and some hundred feet of the argillite being interposed between the two. Again, it seems more than probable that the trap sheets capping Silver Mountain, Silver Bluff and Boundary Hill are all portions of the same sheet. The Divide Ridge sheet would seem to dip under Silver Bluff, unless its south side has been let down by a fault passing through the valley between them, which might possibly be a fault of the existence of which there is some evidence at Contact Ridge, where the beds of the lower division are seen turned up into an almost vertical position against the Archæan rocks. In the case of the other areas, there is no reason to suppose but that they are sheets of trap of varying extent occurring at different places in the formation. From their irregular nature, the extent of those where only the top of the sheet is seen, the rest being covered up by surface deposits, can only be conjectured, the areas where this occurs are shown by the drift color on the map. There are fourteen areas of trap shown on the map, which I shall speak of as Brulé Hill, Wedge Hill. Table Hill, Outlook

Hill, Palisades, Silver Falls, Silver Hill, R 93, R 63, R 160, Silver Mountain, Boundary Hill, Silver Bluff and Divide Ridge traps. Two of these are undoubtedly intrusive, viz., Palisades and R 93. At the former place, the sheet can be distinctly seen in the cliff, as represented in the section, to divide into three tongues in passing eastwards, with argillites between. The lowest one thins out and stops in a short distance, whilst the upper and middle ones continue on, and form the upper and lower benches of the eastern end of the hill. Had these been separate flows, with deposition of sediments in hollows on their upper surfaces, there would be now some recognizable line of division, such as can be seen between the different trap flows of the Keweenian rocks, even where they are separated by no sedimentary beds. But a careful study on the ground showed no such visible division. That there is no recognizable alteration of the argillites overlying the lower sheet, might be considered to disprove their intrusive nature; but when one sees that neither is this the case with those lying immediately below the same sheets, that such alteration is very seldom seen at any similar contacts over the whole region, and that where it does occur, it is slight, and extends over only two or three inches of thickness, and might therefore be easily overlooked, then it is plain that this negative evidence is of no account.

Description of trap exposures

Intrusive sheets.

The R 93 ridge consists of a sheet of the ordinary trap in the lower cherty rocks. It presents some peculiar features, which render its true relationship to the enclosing rocks very difficult to make out, on account of the absence of any sharp line of demarcation between the two, the cherts near the trap seeming to have taken on some of its nature. This will be seen on referring to the notes of the microscopic examination of the rocks, given in Appendix I. The sheet, which in the middle of the north face of the ridge is some fifty feet thick, showing the usual vertically columnar structure, seems to thin out going south, and in following it round the ridge both on the west and east sides. The specimens 317, 318 and 319, Appendix I., were got from the ridge near the south-east corner of location R 93, where there seemed to be three distinct layers of rock—317 representing the middle one, 318 the lowest, and 319 the uppermost. Specimen 320 came from some chert-resembling beds lying on top of the trap sheet at a point about a quarter of a mile north-west of the last-named, whilst 325 is from a similar position at a point about a quarter of a mile west again from the latter place. No. 325 seems to be the only typical chert amongst them, several of the others probably owing their peculiar mineral composition to an injection of trap material

R 93 ridge rocks.

amongst their particles at the time of the intrusion of the sheet. Specimen 323 is from the undoubtedly trappean part of the sheet. Typical beds of the lower division rocks appear both above and below this, all around. Judging from the irregular occurrence of this sheet, its wedge shape, and the alteration of the beds above it, it can be safely asserted that it is an intrusion.

Irregularities of contacts of trap and sedimentary beds.

Irregularities of the lines of contact of the trap with the underlying sedimentary beds are also seen at other places, one of which is shown in the illustration entitled "Trap Flow on Argillites, Animikie Series," where it will be seen that the contact of the trap and argillites is much lower on the left-hand side of the picture than on the other, and this without any signs at the place of any faulting. This might of course be explained by supposing the trap to have flowed out over an eroded surface of the argillites; but in view of the number of other evidences in this district of the intrusive nature of these sheets, it would seem more probable that this is due to the same cause, and that the intrusion has passed from one plane to another in seeking the path of the least resistance. A similar case to this was noticed on the southern edge of the Silver Mountain sheet, and also at the R 160 ridge; but owing to the exposures being nearly covered with detritus, they were not so plain as the one illustrated, which is on the north side of Brulé Hill.

The surface of this latter hill slopes away to the south, where at an estimated distance of about three miles, a high hill is seen to rise apparently composed of the argillaceous division beds, in which several trap sheets can be seen, all of which from their position would overlie the Brulé Hill trap.

Others trap exposures.

Of the other trap areas there is little to say. Outlook Hill appears to consist altogether of trap, but there is so much cover on top that it is hard to say whether some argillite may not be found capping it. The Silver Falls sheet only shows where the creek falls over it, and for a little distance around, with a smooth ice-grooved surface, being otherwise hidden by surface deposits, so that its extent must remain conjectural. It shows a thickness of 25 feet in the falls without the bottom showing. The R 160 trap would seem to overlie the R. 63 sheet, with a slight development of the argillites in between, the latter sheet being traceable down to within a short distance of the former, and seeming to pass under it.

The levels of the lower surface of the Silver Mountain sheet were accurately ascertained at many points all around the hill, and when worked out, seemed to point to a very irregular under-surface. A curious thing bearing on this question is noticeable at Lizard Lake, at

the eastern end of which are visible a few feet of the argillites with the usual columnar trap on top, which would seem to point to considerable irregularity in the under-surface of the trap in this vicinity.

It is a curious fact that none of the dykes, which must certainly exist here, have yet been located, which contrasts forcibly with the coast section with its numerous examples, and it would appear that in the Silver Mountain area they must have weathered away more easily than the surrounding rocks, and so be covered up with the drift.

Microscopical characters of traps.

The nature and lithological affinities of these rocks will be seen by referring to Appendix I, where notes of their microscopical features will be found, (See specimens Nos. 259, 301, 323 and 338,) from which it would seem that they can all be classed as diabases. They vary from very compact dark-colored resinous rocks to medium coarse-grained greyer varieties, these differences showing in different parts of the same sheet, so that no distinction can be made between them in this way. About their field habit there is nothing peculiar, except that they are massive rocks nearly always showing a characteristic vertically columnar structure, sometimes accompanied by horizontal joint planes.

Sedimentary rocks.

Difficulty is also experienced in correlating the different exposures of the sedimentary rocks of the formation, owing to the fact that they seldom retain, for any considerable distance, characteristics by which detached portions of the same bed might be recognized, so that it is only by the general concensus of the evidences that an opinion can be formed of their relationships.

The separation of the rocks into an upper and lower division has been spoken of already earlier in the report, so that nothing remains but to describe the local characteristics of the various exposures of the different kinds of rock within the area under review. To begin then with the lower division, it consists in this district almost altogether of the siliceous rocks, which, whilst presenting great varieties of appearance, have all certain characteristics in common. In association with these are certain dolomitic and calcareous layers. On the map they are represented by the lightest shade of Payne's grey, the gradual mergence of this color into the darker tints, representing the upper division, being intended to show the absence of any sharp line of demarcation between the two divisions.

Lower division.

A study of these rocks in the field, coupled with the microscopic examination of a number of thin sections of different varieties, reveals the facts of their origin. They are seen to have been fragmentary rocks, consisting of rounded and sub-angular fragments which have been subsequently changed very much by the deposition of infiltration-products around their constituent particles, this action having gone so far

sometimes as to change the particles themselves and almost entirely obliterate them. A very good description of their microscopic characters is given in Appendix I. (See specimens Nos. 281 and 325.) In the field they are found to present very various appearances, the same bed to a superficial observer looking quite different at different points not far removed from each other, sometimes appearing quite granular and at others quite compact. They also assume very various colours—grey, light green, black, rusty, etc. Some of them on weathered surfaces are all pitted with little cavities which have hackly surfaces, from which atmospheric influences have removed some soluble mineral, leaving considerable hydrated iron oxide. All varieties contain more or less iron, either in the form of hydrated peroxide, giving them a general rusty appearance, or as magnetite, the percentage of the latter sometimes ranging so high as to give the rock a very high sp. gr., which together with the dark compact fracture so produced would cause the careless observer to mistake it for some of the compact varieties of the trap of the neighborhood. They sometimes also contain iron in the shape of pyrites.

Microscopic characters of cherts.

Ferruginous cherts.

The interstitial matter nearly always consists of silica, which on weathered surfaces, stands out as a fine reticulation from the removal of the more easily soluble particles. When, however, this interstitial matter consists of calcite, as it sometimes does, the reverse is found to be the case, and the particles are left projecting. In these granular varieties the particles seem to be very constant in size, varying from 0.02 to 0.06 of an inch in diameter. Imbedded with these more plainly fragmentary beds are sometimes rusty brown earthy layers, and also compact flinty layers of a black, brown, red, milk-white or green color. Microscopically, these latter can be seen to be due to the action of the infiltrating waters having gone so far as to completely or almost completely merge the particles into the general mass of the replacing silica. The various stages of this process can often be seen in the same specimen or thin section. In some cases ,traces of the original particles are left, as a white, red or brown mottling of the stone, whilst, when the mottling is red on a dark green ground, a very ornamental stone is the result. These varieties sometimes show a wavy, somewhat agate-like, structure, and occasionally crystals of calcite are distributed through them porphyritically.

Infiltrated silica.

Wavy bedding. A very constant and marked feature of the more granular beds is their wavy, irregular bedding, which, together with the general rusty appearance and the reticulation on the weathered surfaces already spoken of, constitute their most salient features. These beds are at places much broken up and fissured, the cracks being filled with crys-

tallized white secondary silica, super-imposed upon which, in one instance in a vug, were found rust-colored rhombohedra probably of altered ferruginous dolomite. An anthracite-resembling mineral is also found occasionally in these rocks in a similar relationship, and one specimen shows nodules consisting of concentrically arranged chalcedony surrounded by radiately crystallized vitreous quartz, with angular fragments of a similar nature imbedded in this anthracitic mineral.

Dolomitic and calcareous layers.

The calcareous and dolomitic portions are only developed to any extent locally, although the whole formation contains more or less of these minerals distributed through it. These beds where developed present a dark grey or cream coloured fracture, the weathered portions being generally very rusty. They often enclose fragments, nodules and sheets of jasper with hackly exterior surfaces, and present other curious features. One specimen, for instance, has the appearance of a conglomerate, and is made up of round pebble-shaped portions of a dark slate colour imbedded in a lighter coloured crystalline matrix, which on exposed surfaces is weathered away, leaving the pebbles standing out. They both effervesce with acid, the matrix, however, more freely than the other portion.* Another specimen is somewhat similar, but the dark imbedded portions are platy and angular, looking more like broken fragments of a thin bed, and though soft enough to scratch with the knife, and generally resembling the dark pebbles of the first mentioned, will not effervesce with cold acid.

From these and other appearances, it would seem that these dolomitic and calcareous layers are most likely due to a similar process of alteration and infiltration to that which has acted in the silicification of the rest of the beds and, that whenever this process of dolomitisation was going on in a bed whose composition and structure admitted of it, and which enclosed thin seams or portions not amenable to these changes, the crystallising power of the carbonates has broken these portions into fragments which have thus got distributed through the mass in such a manner as to form breccias, etc. The want of homogeneity of these dolomitic layers is well shown by the streaky structure brought out on exposed surfaces by weathering.

Dip of Formation.

With a few exceptions, which will be seen by reference to the map and are due to local causes, these lower division beds are found dipping at low angles. The most notable of these exceptions occurs towards the south end of Contact Ridge, where they show in the bed of a stream in an almost vertical position at the foot of a cliff of granitic gneiss.

* Mr. G. C. Hoffmann, who recently made a chemical examination of such a specimen, found that whilst the nodules or pebbles were distinctly dolomitic, the matrix contained no magnesia.

They here consist of brownish red jasperry layers, interleaved with green chloritic slaty portions, which have a resinous lustre on the bedding plane.

Basal conglomerate.

Patches of a basal conglomerate are occasionally found lying in hollows in the old Archean sea-bottom near the northern fringe of the Animikie formation. The imbedding paste is dark, and whilst containing some carbonates, does not in general effervesce with acids, whilst the fragments which are mostly sub-angular, seem to consist in general of granitic material.

Upper division rocks.

The upper division rocks consist nearly altogether of soft, black argillaceous rocks, which, where the bedding planes are numerous, put on a very shaly appearance. The dark colour seems to be due to the presence of carbon in some form as on ignition they lose their blackness and assume a dark buff tint. The amount of contained carbon, and consequently their colour varies very much at different places even in the same bed, at some places being considerable, as at the *East End Mine* at Silver Mountain, whilst at others the lesser amount present causes the argillites to assume more of a grey-slate colour. A very common but a very unequally distributed constitutent is calcic carbonate, and layers of a purely calcitic and dolomitic nature are developed in these upper beds in a very similar way to those mentioned as occurring in the lower division, which is exemplified in the argillites underlying the trap of the R 160 ridge.

Bombs.

The large *bombs* which have been mentioned by other writers as occurring in these beds are frequently found to effervesce with acid and are probably concretionary. This idea is borne out by the fact of the concentric arrangement of the pyrites which is found in them, and which generally shows when they are broken across arranged as a ring parallel to and near the exterior surface. Seen in place, the bedding planes of the enclosing argillites are found to bend up around the spherical ones, whilst in the more lenticular, apparently only partially grown examples, very similar effects are observable.

Silicified argillites.

At some places, whilst the argillites retain their general colour and appearance they are found to be hard from silicification, and sometimes in thin chips show dark rounded grains surrounded by transparent crystallised silica. Again, portions of beds which are at one place typical dark, soft argillites, at other places very nearly approach in appearance the lower cherty division rocks, as in the instance of the beds immediately underlying the trap of Silver Bluff which, in their composition and appearance, resemble much more closely the latter than the former,* whilst stratigraphically they appear to occupy the

* See Appendix Specimen No. 303.

position of the westward extension of the pure argillitic upper beds constituting Silver Mountain.

Partially silicified upper division beds.

For this reason they have been colored on the map, an intermediate tint between those appropriated to the upper and lower divisions. The reason for thus correlating them with the Silver Mountain beds, is found in the fact, that they lie similarly between a trap sheet which is evidently part of that capping Silver Mountain and the top of the cherty division proper. In the Silver Mountain section at the north-west corner of location R 83, the top of these cherty beds is marked by the occurrence of some compact milk-white, red and black jaspery beds, which are also traceable east, through location R 64, whilst similar beds are found underlying these Silver Bluff upper division beds about the north-east corner of location R 65. A curious rock occurs at this place immediately under the trap sheet, whose microscopic characters are described in Appendix I. (See specimen No. 302). It seems to be due to a mingling of some of the trap material amongst the particles of the sedimentary beds immediately adjacent to it, either by original injection or subsequent deposition by waters infiltrating through the trap sheet above, and is somewhat akin to the rocks described from R 93 ridge. Sometimes the silicification has been confined to small portions of these upper beds when we get as shown in the Divide Hill section, the usual soft black argillites with seams and beds of red jasper through them. At the western end of this ridge, which, extending along the north shore of Whitefish Lake, forms the divide between the water-sheds of the Pigeon and Whitefish rivers, this is well shown, lenticules and more continuous bands of red and white chert occurring between the bedding planes of the more argillaceous parts, which bedding planes bend up over the lenticules, producing a general waviness of the bedding approaching that exhibited by the typical lower cherty rocks. I noticed in these jaspery and cherty seams the curious vertical tubular cavities which have been mentioned by previous observers. They have a curious hackly inner surface, and are filled with iron rust as are also numerous little fissures which run from side to side of these seams.

Probable origin of sedimentary rocks.

In fact, the sedimentary beds of this formation, as they appear in the district under consideration, and also as far as observed along its northern fringe, both east and west of this, would seem to have been originally deposited as a series of sands and clays, the former largely predominating in the bottom, and probably near the edge of the basin of deposition, and becoming less prominent and extensive away from this edge, whilst above a certain ill-defined horizon, the clays would form the great bulk of the deposits, and preponderate more and more

as we pass away from the edge of the basin. As one would expect in the clay deposits proper, there would be occasional beds of sand, and in the sandy parts, beds of clay, whilst there would also be beds of sandy clay, and this intermixture would be more frequent as the fringe of the area of deposition was approached. Subsequent infiltration of chemical waters would then produce just such a state of things as already described. The clay beds being impervious would remain unaltered and be now represented by the soft black argillites. The sandy clays would become partially altered and produce the intermediate beds, whilst the sandy beds being quite permeable, would offer no resistance to complete alteration into the different varieties of cherts described, and when this alteration had gone so far as to quite obliterate the particles, we should get the jaspery beds.

These sands would seem, so far as a microscopic examination has gone, to be just such as would be produced by a disintegration of the older Archean rocks, especially of those of the Huronian division of them, and the varying composition of the sands produced from such a variety of rocks would, when decomposed by the infiltrating waters, account for all the various decomposition products observed in their miscroscopic sections and otherwise, such as silica, calcite, dolomite, various decomposition minerals of felspar and hornblende, etc., oxides of iron and so on, and would besides this also account for the varying extent of the alteration produced at different places, the mineral constituents of some of the particles being more readily alterable than others, and supplying by their decomposition a corresponding variety of material.

Archean rocks of district. As shown, the Archean rocks project from the north into the area covered by the Silver Mountain map. Exposures are not very frequent over this area, which is largely drift covered, but where these rocks do show, they present the characteristics of the great division of rocks known as Laurentian. This mass may be said, in general terms, to consist of granitic and gneissic rocks. They have a general pink appearance, from the great preponderance of pink felspar. Occasionally they carry some hornblendic mineral, which, sometimes shows as locally developed bands of schist. Both the gneissic and the granitic variety are at places intersected by a reticulation of veins of a rock which is composed of quartz and pink felspar, the latter largely crystallised and predominant. These veins cut across the foliation of the rock in all directions, sometimes running with it for short distances, and then crossing to another foliation plane. Where they cut narrow and identifiable bands of gneiss they appear to have faulted, them. In one instance, the edges of a hornblendic schistose band, thus

apparently faulted, were turned towards each other on the different sides of the faulting vein. A description of the microscopic characters of a specimen from these rocks obtained near *Woodside's* vein is given in Appendix I. (See specimen No. 277). These Laurentian rocks having been so well and fully described at various times in the publications of this Survey, nothing more need be here said.

Drift deposits.

As before pointed out, the drift deposits cover all the lower lying country, the rock showing only occasionally. As far as such a thing is possible, the area covered to any extent by these drift deposits has been represented on the map, but it is hardly necessary to point out that in such a section of country this can be done, only with an approach to accuracy.

They consist of stiff white clay, sands and gravels. The former seems to preponderate in the greater part of the area forming the basis on which rests the soil. The latter are well seen in the banks of Whitefish River, where exposures frequently fifty to one hundred feet in height are presented, consisting either altogether of gravel or more frequently of clay, sand and gravel interstratified, and containing boulders of granite, gneiss, trap and chert, with occasionally argillite, whilst at one place, veinstone was noticed to occur. These boulders are in most places very numerous.

The general surface of the drift deposits in the valleys would seem to be about 300 feet below the tops of the hills, below which level again the streams have cut deep valleys with steep sides, often 100 feet high, this surface being also further cut up by steep sided gullies forming water courses in the spring, but otherwise dry. The depth of the drift covering represented on the vertical sections appended to the map has been assumed from the data furnished by the sections afforded by these stream valleys.

Glacial striæ.

In passing down the bed of the Whitefish river, and at some other places, several ice polished surfaces of rock were met with, on which the striæ were found to have the following directions at the different places observed:—N. 70° W., N. E., N. 80° E., N. 70° E., E. & W., N. 60° E.

Silver Mountain Vein.

Silver Mountain group of veins.

This vein cuts through the middle of the hill of that name, with a general direction of a little north of east, whilst it dips to the northward at 80° to 85°. It has caused the formation of two indentations in the general contour of the hill, the one on the east side being comparatively slight, whilst on the west side about half a mile of valley has been denuded out adjacent to the outcropping of the vein. It is a

The Silver Mountain group of veins continued

very strong and persistent fissure, showing at frequent intervals right across the hill for a distance of over a mile, appearing to split up at either end and become less strong, and also to change its direction, as shown in the map, where, at its eastern extremity, it is seen to strike about N.E. after leaving the brow of the hill, whilst at the western end it would seem to split up into two branches, both of which take a much more northerly direction than the general strike of the lode, throughout the greater part of its length. The change of strike which would result from the descent from a higher to a lower level, due to the dip of the vein, would not be nearly sufficient to account for this change of direction, which is possibly due to the dying out of the fissure at either end. A theory was at first held locally that there were two veins at the east end, and that the portion of the vein striking north-east was a branch of the main vein, joining it near "the cave," (see Plate IX., fig. 1), whilst it was believed that the main vein must continue on its original course down the valley. A careful examination, however, shows no grounds for such a supposition, and no reason for believing that two veins of different periods of origin exist, one being silver-bearing and the other barren.

Rocks faulted by vein.

The enclosing rock is argillite, surmounted, as usual, by a sheet of columnar basic trap, the faulting of which by the vein is clearly visible at the east end, and amounts there to eighty feet.

Vein characteristics.

Along its outcrop in the trap sheet, and for some little distance below it, the vein is large and solid, and from four to six feet thick, whilst in the argillites below, as one would expect, it does not retain its width so persistently, the fracturing force having in the looser rock become distributed over a wider area, so that at places the vein is only represented by a number of small indefinite stringers distributed through a wide area of the rock, whilst a few feet further on, these have been found to come together and form a large, solid vein. In these solid parts, large caves or vugs occur, several of which open up to the surface on the brow of the hill at the eastern end.

"Gangue" minerals

The vein stone consists of calcite, barite and quartz with fluorite, the different minerals preponderating at different places. The barite seems to be confined to those parts of the vein which are in contact with the trap or a little distance below it, whilst calcite and quartz form the preponderating minerals in the argillites below; the fluor-spar, although plentiful in places, generally playing a secondary part. These differences of gangue give a very different appearance to ore from different parts of the vein. Thus, around the rich ore at No. 4 pit, and in the other end of No. 2 level, the vein stuff was very beautiful, consisting of a crystalline mixture of translucent white and amethystine quartz,

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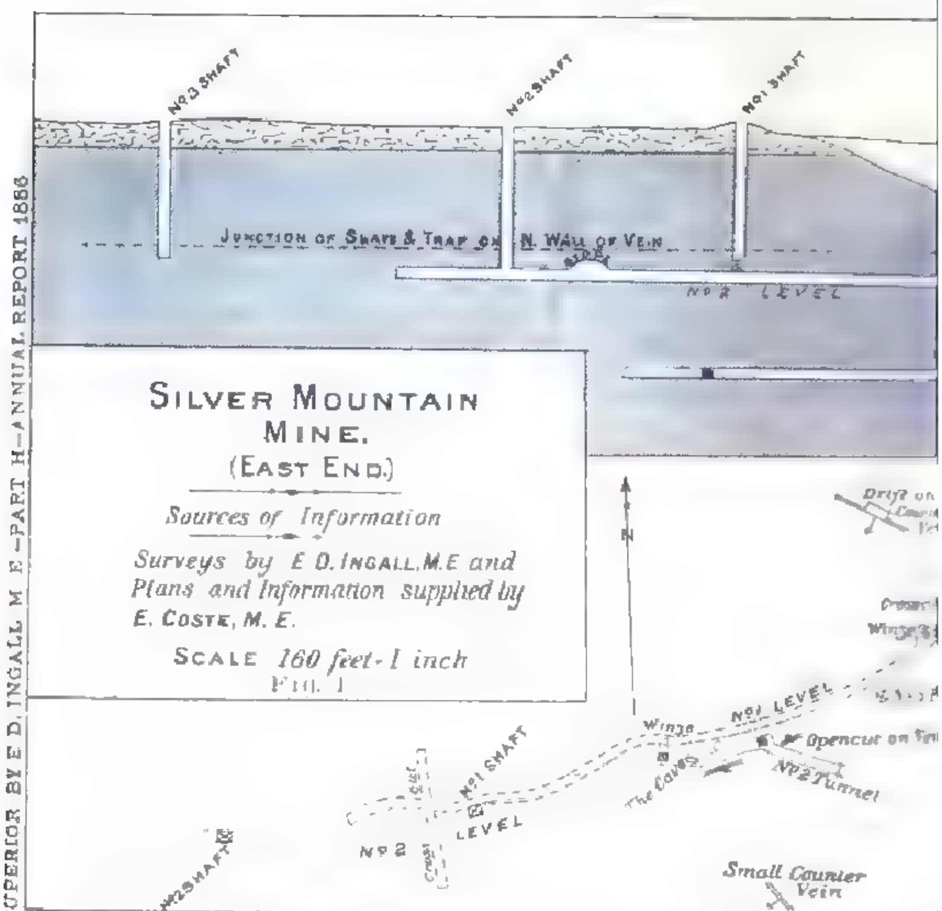
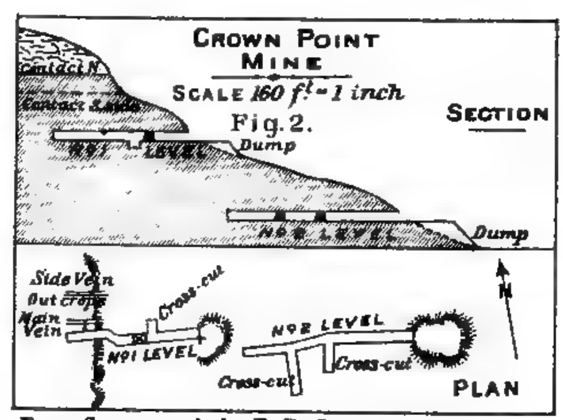


From the nature and incompleteness of the information obtainable, the above is necessarily rat

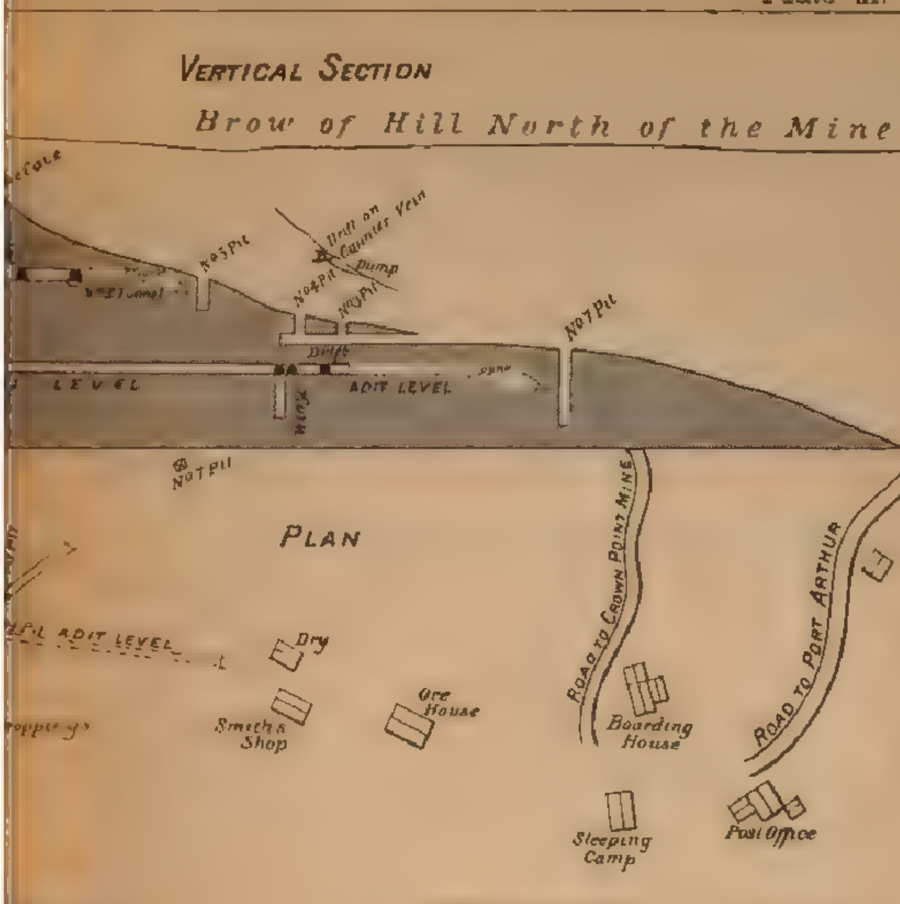


From Surveys made by E. D. INGALL, M. E.

STORY SURVEY OF CANADA.

LL. D., F. R. S., DIRECTOR.

Plate IX.



diagramatic.

Desbarats, Lith.

EXPLANATION.

Trap.

Argillite.

Cross-cuts.

with green fluorite and a little calcite, whilst in contrast to this, in the developments at the other end of the vein, the silver minerals have been found in a white saccharine gangue consisting mostly of white barite and calcite, with a little colorless quartz, and occasionally a little green fluorite. The vugs are generally lined with large cleavage masses and crystals of calcite, and in one there were found well-formed small crystals of that mineral showing the prism, terminated with faces of the rhombohedron, upon which were superimposed small crystals of iron pyrites. The metallic minerals are represented by blende, both light and dark-colored, galena and iron pyrites, with occasionally a little copper pyrites, the silver occurring both native and as sulphide or argentite. The latter is the most common, forming films, sheets and solid nuggets often several ounces in weight, whilst the former occurs in films, but more often in fern-like and wire forms.

The Silver Mountain group of veins continued.

Metallic minerals.

Silver.

The enclosing or country rock of this vein shows no very particular features which distinguish it from the other veins already mentioned, except that the argillite is probably somewhat more carbonaceous in places. This is notably the case around the developments made on the eastern face of the hill, and was especially noticeable in the driving of the adit, when the miners used to come out looking quite black, which characteristic, together with its softer nature, serves to distinguish the argillites in the neighborhood of this vein from that enclosing some other veins in the district. It shows a system of jointing in places, at one in two directions—one N. 15° E., dipping 85° E., and the other N. 85° E., dipping 85° S., the latter direction corresponding to one of the two prevalent in the rocks of the coast section. The capping trap presents no features of marked difference to that already described. The accompanying illustration (Plate IX., fig. 1, p. 72 H.) shows the position of the country rocks on the south or foot wall of the vein and also illustrates their displacement by it, the lower dotted line representing the under surface of the trap sheet on the opposite or hanging wall.

Enclosing rocks.

The work done on this vein is mostly represented in Fig. 1, Plate IX., which shews the developments made on its eastern end up to the end of July, 1887, but besides this, several test pits, etc., have been sunk on the outcroppings, for a distance of nearly 4,000 feet beyond No. 3 shaft, the positions and heights of which will be seen on reference to the accompanying contour map of the Silver Mountain mining district. These developments on the west end of the vein have been made chiefly at three points. The pit nearest to the east line of R. 56 location is only about 8 feet deep. Passing westwards, we come to a small cross-cut tunnel driven into the

Development work.

The Silver Mountain group of veins continued

side of the hill through the argillites for a distance of about 25 feet at which distance it cuts the vein at about 25 feet below its out-crop. From the end of this tunnel, a small shaft has been sunk to a depth of about 30 feet upon the vein. Further west again another similar cross-cut has been driven in through the argillites for a distance of about eighteen feet to the vein, and about twenty-seven feet beyond it. It cuts the vein at a depth of about twelve feet below its out-crop, which is here just underneath the lower surface of the sheet of trap capping the argillites. Below the floor of this tunnel a small pit, about fifteen feet deep, has been sunk on the vein.

Erratum in illustration.

The extent to which the vein has been tested at its eastern end is best understood by reference to Plate IX., fig. 1, which shows the developments up to the end of July, 1887, of which nothing further need be said beyond pointing out that in putting together the various data from which the illustration has been compiled that an error has crept in and No. 3 shaft should be shown at a distance of 820 feet west from No. 2 shaft, instead of as therein represented.

Occurrence of rich silver ore.

The first ore discovered here was remarkably rich. It was obtained from No. 4 pit (Plate IX., fig. 1) and carried a large percentage of native silver and argentite, accompanied chiefly by dark-colored blende. The native metal occured in the leaf and wire form, whilst the argentite occured in leaves, sheets, and as nuggets weighing often several ounces, which latter occurred quite plentifully in some spots. On my visit to the place shortly after its discovery, I saw a cigar box full of such nuggets which had been taken by the discoverer out of a few cubic feet of rock obtained in sinking the discovery pit (No. 4), and I feel sure that several tons of ore could have been obtained from this spot which would have averaged from $1,000 to $2,000 per ton. This was, of course, exceptionally rich and, although silver bearing rock has been found at several other spots in the vein, none of it has been so rich as this, nor, up to the present time, do the developments on the east end of the property seem to have resulted in the proving of any extensive bodies of ore. An encouraging fact is found, however, in the presence of good ore in the vein, running about $127 to the ton* at the west end, about a mile distant from the first mentioned, and it would seem strange if, between these extreme points, the vein were found barren of any bodies of payable yield and size. The developments, however, at the western end of the vein have not yet been extensive enough to throw any light on the extent of the body of ore there discovered.

"Caunter" veins.

Some good silver ore was also obtained in the two small caunter-veins shown on the plan on either side of the main vein. The one on the south shows in the trap, whilst the drift on that on the north is in the argillite just below the trap-bed.

*See Report of Geological Survey, 1886. Part T. Assays Nos. 48 and 49.

The Silver Mountain group of veins continued

The history of this mine has been as follows:—It was discovered in the fall of 1884 by Mr. Oliver Daunais, before mentioned as the locator of the *Rabbit Mountain* vein and of the chief veins of that district. This gentleman, together with his associates, finding such rich ore as mentioned, took up locations including the vein for over a mile. The property was then dealt with in separate halves, known as the East and West ends respectively. The former was shortly afterwards leased to some American capitalists on a twelve months' option, and these gentlemen commenced operations in the spring of 1885, and continued with a considerable force until the end of the same year, when having, it is said, expended about $10 000 in work, their option having expired, and the results of their work not having come up to their expectation, they did not feel inclined to give the price asked, and the mine reverted to the original owners, who then interested with them the Messrs. Trethewey, who had formerly managed the *Silver Islet Mine.*

History of mine

During the year 1886, no work was done, with the exception of a little occasionally undertaken by the owners, which, however, resulted in their striking some more silver bearing rock in the upper tunnel on extending it some little distance beyond the point at which the American company had left off and where the vein had been poor. In the fall of 1886 a company was organized in Liverpool, Eng., to purchase and work the mine with a share-capital of £100,000, under the name of the *Silver Mountain Mine Company (Limited)*, which has carried on operations ever since. According to the prospectus the capital was distributed as follows:—

Purchase of property and costs of floating Co. (paid by vendors)....	Cash,	£30,000	
	Shares @ £1	25,000	
			£55,000
To be allotted to directors in lieu of remuneration for two years, and to other parties for services rendered in connection with the formation of the Co.—Shares @ £1 each....................			9,000
			£64,000
Leaving for Working Capital.....			36,000
Total.....			£100,000

The west end property was bonded also, but after a little work had been done with very encouraging results, the parties got into litigation as to who should have control, which of course put a stop to any further work, and it has remained in that state ever since. Operations were carried on at this point in the winter of 1885-6.

Crown Point Mine.

The Silver Mountain group of veins continued.

The vein here was discovered shortly after that at Silver Mountain. It is about three to four feet wide, although as in the case of the other veins of the district, sometimes split up and rather indefinite, and represented only by numerous branches through the *country* rocks. As far as developed up to the end of 1886, barite and calcite had been the preponderating minerals in the vein-stuff, which were accompanied by a little colourless quartz and some green and purple fluorite, in which gangue, in the orey parts, were to be found blende, galena and pyrites, the silver being in the form of argentite in leaf and nugget.

Enclosing rocks.

The enclosing *country* rock is very similar to that at the *Silver Mountain Mine*, the argillite being black and soft. The enclosing rocks are similarly faulted by the vein, but in the opposite direction, and to a much less extent than at that place, there being here a down-throw on the south side which only amounts to some sixteen feet. The capping trap has been described as a tolerably fine-grained, very much altered diabase by Mr. W. S. Bayley, who made a microscopic study of a specimen of this rock taken from near the vein. (See Appendix I., No. 259).

Developments.

The workings on the vein have all been prosecuted in the upper portion of the black argillites, and are comprised within a depth of 140 feet below the capping trap as shown in the illustration (Plate IX, fig. 2) which gives the developments made on the vein up to the end of 1886. These have all been made by the original owners, who have not had capital enough at command to open up the vein to a greater extent, although the results have certainly been encouraging.

Another vein.

About ten chains N.W. from this place occurs another very similar but smaller vein which was found cutting the capping trap, and a small amount of test work done to trace it down into the underlying black shales which was, however, stopped before anything very definite had been proved, owing to the parties who were prosecuting the work, finding that the vein was not on their own property.

Palisades Vein.

Vein characteristics.

Here a vein has been located and some little work done to test it. It contains the usual metallic minerals, which are plentiful in places, in a gangue of calcite with colourless white and pale amethyst quartz and a little fluorite occurring in scattered particles and mammillated layers, the surfaces of some of which have a tendency to assume an amethyst colour, the rest of the mass being emerald green. The vein,

where worked on, is entirely in the soft black argillites and shales below the lower tongue of the trap sheet which caps this hill. Of this trap, Mr. W. S. Bayley says "this is a medium-grained diabase with the typical diabase structure." (See Appendix, specimen No. 338).

The Silver Mountain group of veins continued.

The developments to the end of 1887, consisted of a small cross-cut tunnel driven southwards into the base of the hill at a depth of about 40 feet below the outcrop of the vein and the base of the trap sheet, which, at a distance of fifty feet in from its mouth has intersected the vein, from which point a shaft has been sunk on it said to be fifty feet deep, and to have shown the enclosing rock to be argillite all the way down. At the end of the tunnel, the vein consists of numerous branches and stringers distributed through a thickness of about ten feet of the argillites.

Developments.

Scripture's Vein.

This is a two to three feet vein showing in the capping trap bed of Silver Bluff, and the sedimentary beds below it. It is filled mostly with crystallised barite, giving the veinstone a confused interferent platy structure. The vein has a somewhat banded appearance at this place, owing to the presence of a two to four inch rib of green fluorite on each wall, and to a banded appearance of the barite filling near the walls. A little white quartz is also present. Very little metallic minerals were visible, but as only sixty feet of the vein was exposed in the cliff, the talus covering up all below, and as no development work had been done on it, very little is as yet known about it. No appreciable faulting of the rocks has been produced by the fissure.

Vein characteristics.

The enclosing rocks of this vein consist of an upper bed of the usual trap of the district underlaid by a highly siliceous, wavily-bedded, flaggy rock with marked vertical jointing in two directions. These have already been described more fully, and their microscopic characters referred to. (See Appendix I., specimens, Nos. 301, 302 and 303).

Enclosing rocks.

Silver Hill.

Two veins have been located at this place and worked upon to a small extent. The most southerly one presents the feature, at one opening, of two distinct ribs, one made up of barite crystallized in radiating platy forms, whose interstitial spaces are filled out with crystalline colourless quartz, whilst the rest of the vein at this spot consists for the most part of calcite, in coarsely crystallised masses, accompanied by a fair amount of, mostly colourless but sometimes amethystine, quartz, some barite and a little pale green fluorite. At another open-

Vein characteristics.

The Silver Mountain group of veins continued.

ing again, the vein consists almost altogether of calcite, with quartz and green fluorite and very little barite. The work done on this vein to the end of 1886, consisted of a few shallow test pits, sunk at intervals apart, over a distance of 150 yards on the outcrop of the vein.

The other vein cuts the hill and is smaller and less definite than the last, averaging about one foot thick as far as exposed, and showing similar filling to the other, only that the barite is absent The work done to the end of 1886 was slight, consisting of three small open cuts driven in on the vein, one above the other, on the west side of the hill. The enclosing rocks of these veins consist of highly ferruginous cherty rocks, accompanied at places by compact jasper bands and ferruginous dolomite beds which, on the hill, are capped by a bed of trap. A little native silver and argentite has been found in the vein on the hill.

Silver Falls Vein.

Vein characteristics.

This is a large vein, and, as far as proved by the present developments, differs somewhat from the rest of the veins in the district. In the shaft, at the surface, it showed vein matter over a width of fifteen feet, but at the time of my visit, October, 1886, the work done had not been sufficient to demonstrate exactly its dimensions and nature. In a sample of about ten pounds, obtained by the owners from some distance down in the shaft, the vein stone consisted of an intimate mixture of compact quartz with some dark material, giving it a general dark greenish-grey appearance, which was relieved occasionally by the occurrence of quartz of a pale pink, amethyst, or more often white colour, with pale pink and cream-coloured dolomitic spar occasionally. The jointing surfaces were faced with a dark, probably plumbaginous coating. At other places, the pink spar constituted the bulk of the vein, and on the presence of this spar and its resemblance to similar vein-stone which had accompanied the silver of *Silver Islet*, the owners based hopes that similar rich ore might be found in their vein. In places a good proportion of finely disseminated iron pyrites was visible in the above described sample.

Enclosing rocks.

The enclosing rock of this vein consists of the jaspery and cherty rocks of the lower division, which here, adjacent to the vein, present the unusual feature of being much contorted, which is in great contrast to the usually flat position of the rest of the Animikie formation of the vicinity. This disturbed condition will be apparent on referring to the map, from an examination of which it will be seen that the beds turn down sharply on the hanging wall of the vein, whilst they dip steeply the opposite way on the other side, and again reverse their

dip about seventy paces further down the creek, where they show in a little fall of about twenty feet. This is probably a local effect produced by the vein, which has probably faulted the rocks. These rocks here carry at places little interbedded lenticular patches of crystallised vein minerals, which enclose sometimes a little iron and copper pyrites, and all of which are probably due to infiltration into spaces formed by the folding of the rocks.

The Silver Mountain group of veins continued.

To the end of 1886, the work done consisted of a fifty-feet shaft sunk on the vein, from which, at a depth of about forty-five feet, a cross-cut fifteen feet in length was driven across it. Besides this, some surface strippings were made, extending over a distance of about fifty yards of the outcrop of the vein.

Work done.

R 64 Location.

Several large veins occur on this property, of thicknesses varying from three to eight feet, and showing all the characteristics of definite fissures. In their contents, the various forms of quartz preponderate, which are accompanied in places by varying proportions of green fluorite, calcite, and occasionally a little barite. At one exposure, the vein consists almost entirely of solid vitreous silica, and has a marked, banded or combed appearance from the "cone in cone structure" produced by the different coloured layers (amethyst, white, translucent, etc.,) of the quartz being arranged parallel to the faces of the terminal pyramid. The fluorite seems to have been mostly deposited between the irregular surfaces of these layers. The metallic minerals represented by blende, galena and pyrites occur occasionally, both disseminated, and the latter also as very thin films coating cleavage planes, jointing, etc. The enclosing rocks comprise the jaspery, magnetitic and rusty siliceous beds of the lower division. (See Appendix I., Spec. No. 281.)

Vein characteristics.

The work done has been so far confined to the tracing of the veins and to the sinking of shallow test pits on their outcrops.

Work done.

Other Veins.

Several other veins have been located in this district on which a little test work has been done, viz.: on Locations *R 79* and *R 111*, and on *Tchiatan's* vein on Location *R 115*. These are all in the siliceous rocks of the lower division. *R 79* vein is filled at one place with a gangue of saccharine quartz and spar, the latter mostly calcite, whilst at another opening it consists altogether of compact vitreous, iron-stained quartz resembling the gangue of the gold veins of the Huronian areas of this region. It carries a little disseminated pyrites, galena and blende.

The Silver Mountain group of veins continued.

The *R 1H* vein is very similar to most of those already described, carrying a little of the usual metallic minerals in a gangue of calcite, amethystine and colourless quartz and green fluorite. On this vein the prospecting work done to the end of 1886 had been inconsiderable, consisting of several test pits on the outcrop of the vein, tracing it for a distance of about two hundred feet, and a small thirty foot tunnel driven into the base of the ridge on which the vein outcrops and cross-cutting the same at a depth of about twenty feet below the surface.

Tchiatan's vein is large and compact, about three to four feet thick, on which, besides some surface work in the outcroppings of the vein, a shaft has been sunk said to be forty feet deep. Judging from the ore dump at this point, the vein has carried considerable quantities of blende, which, with a little galena, occurs in a gangue similar to those already described, but carrying occasionally a little flesh-coloured barite. The blende is light-coloured, and occurs largely crystallized in solid ribs and masses.* An examination of the rock broken shows that the beds encountered in sinking this shaft somewhat resemble those already described as occurring at the south end of Contact Ridge, viz., red jaspery beds separated by dark-green chloritic layers.

Woodside's Vein.

Vein in Archean rocks.

This example differs from the others within this area, in that it occurs in the Archean granitic and gneissic rocks underlying the Animikie, the northern fringe of which is most probably located in this immediate vicinity, being covered up by the drift which hides every, thing for some distance to the S. of the Whitefish river. The vein in its nature and contents is very similar to the rest, and carries blende-galena and pyrites distributed through the usual gangue in moderate profusion.† The pyrites occurs occasionally in peculiar ring-like or rather more hexagonal arrangements in the calcite, the centres of the rings etc., consisting also of the latter mineral. Purple fluorite also occurs in the joint fissures of the enclosing granitic and gneissic rocks. The work done up to the middle of October, 1886, consisted of some explorations and pits in the out-crop of the vein over a distance of about 100 yard-, and of a twenty-five feet shaft, sunk on the hanging wall, which had just reached the vein at that depth.

Whitefish Lake Group.

The chief examples of the vein phenomena of this group which were visited are described below, together with the special conditions of their occurrence. They all occur in the district immediately sur-

*See Report of Geological Survey of Canada 1887, Part T, Assay No. 43.—Idem, 1886, Assay No. 45
†Idem, Part T, Assay No. 44.

rounding this Lake. They are known as the *Sunset Lake, Medicine Bluff, Caldwell's, Scripture's, Hurlburt's, Geroux's, Laplante's, Arrow River Mining Co.'s* and *Whitefish Lake Mining Co.'s* veins, and all except the three first mentioned, which are in the upper black argillite division, occur in the lower siliceous rocks, and are located within a distance of about two miles from where these rocks abut on the Archean gneissic and granitic rocks to the north. Enclosing rocks.

General characteristics of veins of the group. The veins visited in this area were found to have much the same contents as those already described, viz., blende, galena and pyrites in a gangue composed of very varying percentages of calcite, and colourless, white or amethystine quartz with green fluorite, barite being only occasionally present. The metallic minerals are by no means present at all the places at which these veins have been exposed, being fairly plentiful at some of the places, whilst at others, the gangue minerals are almost or entirely free from them.

Up to the end of 1886, no extensive bodies of silver bearing ore had been found in any of them, and in fact at those places where good silver had been reported as found, it had been removed so completely as to render it difficult to find more than traces of the silver minerals here and there.

Geological features of the district. The rocks of this area show much the same features as those presented by the Silver Mountain district, viz.: a general division of the Animikie rocks into an upper argillaceous and a lower siliceous division. The latter form the northern fringe of the formation, and occupy all the lower lands to the north of the range of hills, forming the divide between Whitefish Lake and Whitefish River, their line of contact with the Archean rocks to the north, being roughly coincident with the course of that river. Passing southward from this, one comes in the higher levels of the south side of the river valley to the more argillaceous beds of the upper division, which shew, however, some tendency in character towards the lower siliceous division, whilst further south on the other side of the lake the lower beds are rarely if ever seen, and the upper argillaceous beds seem to be more largely developed and to closely resemble the typical black soft argillites of this formation.

Traps. These beds in the already mentioned range of hills north of, and in the others surrounding Whitefish Lake are all capped at about the same level by the usual columnar trap, whilst at lower levels on the north shore of the lake there are evidences of the existence of another and inferior sheet of the same. This inferior sheet shews at the water level along most of the north shore of this lake, and is noticeable in passing north along the trails leading from the lake to *Laplante's* vein near Little

Gull Lake, and to the *Arrow River Mining Co.'s* vein on Whitefish River.

Vertical section of the formation—Laplante's Trail.

The vertical dimensions of the sections obtained in passing over these trails were measured with the aneroid on several occasions, and gave the following mean results—

Trail to Little Gull Lake:—

500 feet	..................Top of hill
400 to 500 feet	..................Upper trap sheet.
260 " 400 "	..................Exposures of argillaceous beds.
200 " 260 "	..................Covered.
0 " 200 "	..................Over lower trap sheet.

In descending the northern face of this hill, these same argillaceous beds were found to underlie the upper trap, but seem to have thinned out in this direction, and they measure here only about 50 feet, the lower siliceous beds occupying all below this until the Archean surface rises from beneath them to the north. To the west of this hill lies the one on whose northern and eastern slopes are located the workings on *Giroux's* and *Hurlburt's* veins and the lower surface of the trap sheet capping it having been measured in the same way, is found to occur at a height of about 450 feet above the lake with a thickness of about 100 feet, whilst further north, the lower surface of the trap capping one of the Outpost Hills immediately north of *Laplante's* vein, was found to be at an elevation of about 700 feet above Whitefish Lake, and its upper surface at nearly 800 feet.

Another vertical section of the formation.

In passing over the trail a mile or two west from the last mentioned one, from the lake to the *Arrow River Mining Co.'s* works, the following vertical section was obtained in a similar manner.

360 feet	...............Top of hill	
280 to 360 feet	.......Upper trap sheet	} shewing in a hill a little
180 " 280 "	.......Argillaceous beds	} to the east of trail.
140 " 180 "	.......Covered	
0 " 140 "	.......Over lower trap sheet.	

This hill is one of those forming the divide range between the Lake and Whitefish River, and in descending its northern face a diminishment similar to the above-mentioned, is observed of the thickness of the upper division beds lying between the capping trap sheet and the lower siliceous division rocks, the latter constituting all the rock exposures along the trail from this point, on in a northerly direction till their contact with the Archean is reached.

In neither of these sections is the lower trap sheet met with in descending the northern face of the range, as the ground never comes

down to the level at which its upper surface shews on the Whitefish Lake side, so that the question as to whether it extends that distance, and therefore underlies the cherty rocks there exposed, or whether it thins out in going north, is still unsettled.

The composition of these various rocks has been described in the foregoing parts of this report, and the features presented by them at the various points visited, are dealt with later, so that nothing further need here be said.

Sunset Lake Vein.

Whitefish L. group of veins.

This vein at the place where the chief development work has been done upon it is enclosed in siliceous beds, lying on a sheet of trap which shows in a little cliff to the south of the workings on the north shore of the little lake, known by the above name. About 100 yards to the north of this spot, beds of a higher horizon show in a bluff, consisting of black argillites capped with the usual columnar trap of the district. The vertical section of the beds here, is therefore, as follows, commencing from the level of Sunset Lake upwards.

Vertical section of the formation.

130 to 160 feet	......An estimated thickness of columnar trap.
110 " 130 "	......Black argillites and shale.
30 " 110 "	......Covered.
20 " 30 "	......Covered (at thirty feet workings on the vein in the siliceous beds).
0 " 20 "	......Lower sheet of trap.

This brings us to the top of the ridge separating Sunset Lake from Whitefish Lake, from which point there is a fall of about 280 feet to the level of the latter lake, in the descent of which by the trail, however, the rocks below the upper trap are all found to be covered up.

Intrusive trap sheet.

The lower trap sheet shows considerable evidence of being an intrusion. It is darker and more compact than the upper one, especially towards its upper surface, where it has been in contact with the overlying rocks, which, by cooling this part more rapidly than the central portion, would have produced this compactness, whilst in descending the little cliff, we find the rock assuming a much coarser and more distinctly crystalline texture. The extremely smooth upper surface of this sheet would also seem to point to its being an intrusion amongst smoothly bedded rocks, as the absence of any grooving or polishing forbids the supposition that it is, like some of the similar smooth surfaces of this district, due to ice-planing.

The work done on the vein has been very little, consisting of a fifteen-feet test-pit and some surface work in the outcrop at various points.

Medicine Bluff.

Whitefish L. group of veins continued.

Two veins have been tested to a small extent in this vicinity, on mining locations R 208 and R 119 respectively. The work to the end of 1886, at the former place, consisted of a small cross-cut, driven about thirty feet through the argillite into the side of the bluff near the top to intersect the vein, which here dips at 80° to the north, from the end of which drift a little pit has been sunk. These developments have not been prosecuted far enough to prove much about the vein. Medicine Bluff itself consists of black, soft argillites and shales, capped by a columnar bed of trap. About half a mile to the east of the before-mentioned workings, the section presented in the bluff is as follows:—The contact of the argillites with the trap is found to be 400 feet by aneroid above the water of Whitefish Lake, the trap having an estimated thickness of from 100 to 150 feet above this point, whilst below it the argillaceous beds show at intervals for a distance, vertically, of about 150 feet, everything below this being covered up by detrital matter fallen from the cliff above. The name Medicine Bluff is derived from the occurrence in the face of the cliff of a mineral efflorescence, which is probably alum, stained with hydrated iron oxides derived from the re-action of the oxidation products of the pyrites on the shale in which it occurs. It is said that the Indians gather it for medicinal purposes, hence the name.

Location R 208.

Vertical section of the formation.

Location R 119.

The vein on R 119 location lies about half a mile to the west of the last-mentioned point, and skirts along the base of a bluff which rises out of a swamp, and consists of columnar trap for the greater part of its height of 300 feet, as measured by aneroid. Just at its base, argillites are seen to underlie it, only showing, however, a thickness of a few feet above the surface of the swamp. They appear to be mostly soft, but not so dark in color as the typical black argillite, whilst at other places there are portions whose coarser grain would relate them more to sandstones. The work done consists of a cross-cut driven in through the argillites of the hanging wall for a distance of about twenty feet, when it reached the vein. At this spot, the edges of the argillites lying in a horizontal position come abruptly up against the trap forming the cliff, and there is some appearance of this trap being a dyke running parallel with the vein, and cutting both the before-mentioned horizontal trap sheet and the underlying argillites; but further work is required to prove this. It is also difficult to decide, without working over a much larger area than was possible in visiting this spot, whether the capping trap here found at the level of the lake is part of that sheet which in the vicinity rests on the argillites at

a height of 400 feet above this level, and is faulted down into its present position, or whether it is a sheet occurring lower down in the formation. Whitefish L. group of veins —continued.

Caldwell's Vein.

This vein shows a little to the west of the trail going to Little Gull Lake from Whitefish Lake, cropping out on the side of the hill which rises to the north of the western end of Whitefish Lake, over which the trail passes. Where seen, it is enclosed in rather hard, dark argillites, which show a tendency in places to approach in their nature the more siliceous lower division beds. The vein shows here about four feet thick, dips steeply to the south, and passes a little above this spot upwards into the trap sheet which here caps the argillites and forms the top of the hill. The vein is here seen to have faulted the enclosing rocks several feet. Little or no work has been done on it. Rocks faulted by vein

Scripture's Vein.

A vein known by this name occurs some distance further up this trail, where it is seen to be enclosed in the typical jaspery and wavily bedded ferruginous cherty rocks of the lower siliceous division, which, in the neighbourhood of the vein, are plentifully penetrated in all directions by stringers filled with crystallised quartz, the vein itself being entirely made up of this mineral of the various colours prevalent in the district, and showing a tendency to a cone-like structure. The vein is solid, and four feet thick, dipping to the south. The work done consists of an open cut driven into the side of the hill which it intersects.

Hurlburt's Vein.

Passing westwards from *Scripture's*, we ascend the steep east-facing slope of a hill, showing about 150 feet of the wavily-bedded silico-ferruginous rocks capped by a sheet of trap about 100 feet in thickness. A little pit about six feet deep has been sunk in the vein where it outcrops about fifty feet below the trap. About half a mile further west, on the run of and presumably on the same vein, some little work has been done in its outcropping, and it is said that good ore, carrying native silver, has been obtained at both of these places. None, however, was to be seen at any of the accessible points, although an assay of some picked pieces from the first-mentioned developments gave nearly two ounces to the ton,* showing that the metallic minerals therein contained carried silver, as none of the silver minerals proper

* See Report of Geological Survey of Canada, 1887. Part T Assay No. 38.

Whitefish L. group of veins —continued.

could be detected in the rock, even with the lens. The latter, or most westerly workings, occur on the north slope of the same hill, and the enclosing rock of the vein is here a hard, dark silicified argillite, the edge of the capping trap sheet showing a short distance to the south at a little higher level than the workings.

Geroux's Vein.

The workings at this place are apparently upon the extension of *Hulburt's* vein, and are situated on the north face of the same hill, about half a mile west of the last-mentioned point. At *Geroux's* workings, the enclosing rocks belong to the typical cherty and dolomitic beds of the lower division, between which and the overlying trap sheet intervene some ten to fifteen feet of the black, soft argillites which show in a thirty-feet cliff about one-quarter of a mile south from the workings.

A curious feature here presented consists in the occurrence amongst the cherty rocks proper of a light green dolomitic rock, whose colour is found to be due to the plentiful distribution through it of a pale green aborescent or fibrous mineral, probably actinolite, which has most likely been developed in the dolomitic bed by subsequent metamorphism.

Below this point, the ground falls away rapidly to the north and west for a vertical distance of about 200 feet, over which area nothing but chert and jasper beds are to be seen, which a mile west of this are found to abut against the pale pink gneissic rocks of the Archean.

Laplante's Vein.

Contact of Animikie and Archean rocks.

About a mile and a half north-east from the last mentioned, on the line of junction between the Animikie and Archean rocks, test shafts have been sunk on two veins running parallel to each other on either side of a ridge of the latter, which is flanked on both sides by the Animikie jaspers and cherts. The shaft on the east vein is about thirty feet in depth and sunk on an indefinite vein or lot of branches and stringers distributed through a dark-green, *slickensided*, chloritic material, which may be possibly part of the vein, and having a general dip towards the north-west, whilst the strike is north-east. In the thirty-feet shaft on the opposite side of the ridge, a well-defined, solid four-feet vein is visible, going down about vertically as far as followed. It has evidently faulted the enclosing rocks, as the one wall consists of the gneiss, etc., of the above-mentioned ridge, whilst the ferruginous, jaspery and cherty beds form the opposite or W. wall. Just at the

top of the shaft, the original contact of these two systems of rocks is well shown, the gneiss being overlaid by a thin sheet of jasper in a horizontal position, which at places has been denuded off so as to be no thicker than one's hand. Whitefish L. group of veins continued.

Arrow River and Whitefish Lake Mining Companies.

At the place shown upon the Sketch Map, the two above-mentioned companies have done a small amount of testing, both working on the same vein. It shows as a solid four-feet vein on the surface at one place, whilst at another there are eight to ten feet of solid vein stuff, but as is so common in these veins when followed down, it is at places all split up. Its dip would appear to be to the south, although the developments have not gone far enough to prove exactly. It outcrops in an area of the typical lower siliceous beds which show as the surface rocks for over half a mile south of the vein, being exposed along the trail leading to this place, and are again seen on the Whitefish River, about a quarter of a mile to the north of the same spot, where they come in contact with the Archæan. The enclosing rocks present no peculiar features, except in the occurrence towards the bottom of the shaft of a rock having more the color and texture of some of the argillites of the upper division, but which differs from them in being much silicified and hard. The bedding planes of the rock were found to be frequently coated with a black material that rubbed off and resembled graphite.

A peculiar feature is presented by some of the calcite in the gangue, which often has quite a pearly lustre and tendency to curvature of the cleavages, which variety is often stained dark by some material not determined, but that it is merely calcite is shown by its free effervescence with acids and by its cleavage angles. Other somewhat marked features are the occurrence of the quartz in veins intersecting the calcite and crystallized in the freer spots and cavities, and the presence of dark streaks through the gangue, which, judging from their dark-greenish-black, lustrous appearance, are probably some chloritic decomposition product. The work done consists in the main of two shafts sunk on the vein, each about thirty feet deep, at a distance apart of about 900 feet, with some little workings in the outcrop between them.

About half a mile to the south of this point, a couple of shallow pits have been sunk on a solid five feet vein which is enclosed in the siliceous rocks. As far as can be seen it dips to the north at 65° to 70°.

General Characteristics of the Silver Veins.

In order to complete the study of this subject, it will be here necessary to give a resumé of the characteristics of these veins, and to mention some of the general conclusions which may be based thereon.

Strike directions. A study of the Sketch Map will show that as regards their strike-directions, they resolve themselves into three groups: A N.W. group, a N.E. group and an E. and W. group. The N.W. direction of strike is most characteristic of the Coast group, the famous *Silver Islet* vein being the most striking example of this, whilst all the rest of this group run parallel with it. The chief example outside of this is the *Beaver Mine.*

All the veins of the Rabbit Mountain group, with the already mentioned exception of the *Beaver*, may be classed as N.E., whilst the *Thunder Bay Mine* vein also belongs to this series.

The last series do not run in general due east and west, but a little N. of E. and S. of W. To this series belong nearly all the chief veins of the Port Arthur group, with the exception just mentioned, and nearly all the Silver Mountain group.

Dips of veins. The dip of these veins is not sufficiently worked out to form any basis for classification as most of them have not been followed deep enough to be quite sure of what their real underlay is, and some of them have changed their direction of dip in depth as at the *Shuniah Mine.* In this connection, it may be useful to suggest that when too little of a vein is visible to decide its direction of dip, the study of the displacement of the rocks generally produced by these fissures will often aid in determining this point, as in nine cases out of ten, the lowering of the rocks has been on the hanging wall side, whilst the extent of the displacement may give a rough idea of the strength of the fracturing force producing the fissure, and therefore of the extent and definiteness of the vein.

Physical characteristics of veins. The physical characteristics of these veins present some features of interest worthy of notice by those working on them. These, as one would expect, vary with the nature of the enclosing rocks; in the different varieties of which the fissuring force would have different effects. Thus, as a general rule, the veins in the trap beds are wide and solid, the proportion of the wall rock enclosed by the vein filling being comparatively slight, whilst in the argillites below, they are apt to be very irregular, and at times difficult to follow, being at one place large and solid, and at another all divided up, and represented by numerous small stringers and branches distributed through a great thickness of the argillites, these changes often occurring very suddenly in following

them. This is just what might be expected of the action of a force tending to produce a fracture in such rocks, for where the argillites were more compact, the force would act only over a small space, whilst in the more shaly parts there would be a tendency to give rather than to fracture, and the force would get distributed, and again, the trap being a more rigid and compact rock with jointings far apart in it, and those vertical, one would expect a wider fissure with definite walls. This would also apply, of course to the lower siliceous division where solid, whilst in the varieties with much bedding structure, the results would resemble more those produced in the argillites, and this is found to be so. This would probably account for the great width and solidity of most of the Coast group of veins which, in a general way, distinguish them from most of the rest of the veins under study; the former having been opened upon nearly altogether where they intersect trap dykes, or in their immediate vicinity, whilst the workings on the latter are almost altogether in the veins where they cut the argillites.

Irregularities in structure of the veins. These irregularities in width have in some cases disheartened operators, and led them to believe that their vein had "pinched out," but in view of the explanations just tendered it may be usefully pointed out that such fears will generally prove to be unfounded, and that where the extent of the accompanying faulting of the enclosing rocks is considerable, and there is other evidence to believe that the fracturing force was such as to produce an extensive and persistent fissure, a little pluck and energy in following it up will generally take one through the disturbed parts to where the vein will again be found wide and solid, and this has been found to be the case already in several instances. The definiteness of the bounding walls of the veins, it need hardly be pointed out, also varies with the rock they are in, in a similar way. Some of them, as at Jarvis Island, show *slickensided* walls in the vein matter itself, and other evidences of movement since filling. *Slickensided* surfaces are, however, not very common in the district. **Slickensides.**

Contents of the veins. The vein-filling minerals consist in general of quartz, barite, calcite and fluorite constituting the basis of the gangue, in which occur the different metallic minerals, viz., blende, galena, pyrites of various species, and occasionally some sulphurets of copper, whilst the silver in the orey parts occurs as argentite and in the native state, the former being the most common. At places, the veins carry a dark green, probably chloritic material which on some surfaces has a bright, waxy lustre, whilst occasionally a soft, greasy, talcose material, probably Saponite, accompanies the ore, notably at the *Beaver Mine*, and to a lesser extent at one or two other places. Carbon in various forms has also been found here and there, whilst in some of the *vugs* in the veins, which

Chloritic and talcose materials. **Carbon.**

have been found near the surface, stiff clay and ochreous material have sometimes been obtained, along with nuggets of argentite, the former, however, having evidently been washed in from the surface, and has thus imbedded the silver minerals already existing in the *vugs*.

Silver Islet vein exceptional.

These, then, are the mineral constituents of these veins but the *Silver Islet* vein forms somewhat of an exception, in that it carried, besides these, various arsenical and antimonial ores of silver with compounds of nickel and cobalt, and other metallic minerals which have, so far, not been found in the rest of the veins. Other salient features were the pink and cream-colored dolomitic spar which so frequently formed a characteristic and prominent constituent of the gangue of the rich ore, and the predominance of native silver in the rich parts, whereas in the rest of the veins, though this form of silver occurs in considerable quantity at places, yet argentite seems to be the form in which it is generally found.

Gas and mineral waters.

It is interesting to note that both the mineral waters and the inflammable gas that were met with in opening up the *Silver Islet Mine* have also been encountered at other points in the district.* At the *Rabbit Mountain Mine*, in one of the lower levels, I saw water running over the breast of the drift which gave off a faint odor of sulphuretted hydrogen, and was depositing a white flocculent material, whilst both at this place and at the *Beaver Mine* I was informed that small quantities of inflammable gas had been met with.

Variations in texture, etc., of gangue.

The general appearance of the filling differs very much at different places in the same vein, owing to the frequent variations in the proportions of the different minerals constituting it, and to the various colors some of them assume. The texture of the vein rock differs also very much, owing to the differences of crystalline aggregation of the minerals, varying thus from a compact, vitreous, crystalline or saccharine to a very coarsely crystalline gangue, whilst at other places, the vein-stones present more of a brecciated appearance, consisting of angular fragments of the enclosing rock, cemented together by the gangue minerals, and often with empty spaces between.

The coarser textured vein-stones are generally found, as might be expected, where the clear space to be filled up has been large, which, as pointed out, has generally been in the trap, so that the Coast Group of veins often present this character, as do the others also where they outcrop in the trap, and it is in these positions that the large crystal-lined cavities and *vugs* occur. The minerals which mostly affect this

* Inflamable gas also comes up at several points in and around Thunder Bay, causing considerable ebullition in the water and keeping it open all the winter. On one of these Mr. Murdoch, C.E., has placed a small tank connected with an inverted funnel anchored on the bottom and it affords sufficient gas to keep a good sized light burning.—A. R. C. SELWYN.

connection seem to be the barite and calcite, especially the former, the frequency of whose occurrence characterizes the gangues of the above-named group of veins, which thus contrast with the more commonly finer grained vein stones of the other groups, which consist more generally of varying amounts of calcite, quartz and fluorite. It need hardly be pointed out, however, that these distinctions are only based on the general prevalence of certain constituents and conditions of texture, etc., and not on any hard and fast lines.

Distribution of metallic minerals in the veins.

Through these different kinds of gangue are distributed the metallic minerals in a very irregular manner. Sometimes they are very plentiful, whilst long stretches of vein are frequent, which are quite free from them. When they are present, they occur mostly in bunches and more widely disseminated whilst more rarely they show as streaks parallel to the vein walls, a mode of occurrence more frequently affected by the Coast group than by the others.

Mode of occurrence of silver ore in the veins.

The distribution of the silver minerals in the veins is similarly very irregular, so that the rich ore generally occurs in detached bodies of very varying dimensions, surrounded by very poor or quite barren areas of the vein; the frequency with which they occur and their extent when found, constituting, of course, all the difference between success and failure of the mines.

Descriptions of the different minerals of the veins.

The details of the characteristics of the different minerals are as follows:—The quartz occurs massive, crystallized, and in granular crystalline form, transparent, white and amethystine in color, the latter being very characteristic of these veins. It sometimes fills the whole vein, and is occasionally seen crystallized in the wedge-shaped spaces between radiately arranged crystals of barite, and also similarly a jaspery form was seen to have filled out spaces between calcite crystals. It is also very frequently the case that thin films of colorless quartz are found in the cleavage planes and minute fissures in the calcite, which films do not show on the fresh fracture, owing to the similarity of appearance of the two minerals, but stand out on weathered surfaces as a regular reticulation from the removal of the surrounding calcite. The smaller vugs are generally lined with pyramidal crystals of this mineral. It is more common in the veins where they occur in the sedimentary beds than where they are in the trap. There is nothing particular to note about the barite except that it is generally white, but sometimes flesh-colored, and occurs sometimes crystalline, but more often largely crystallized in confusedly interferent platy combinations. The calcite occurs both crystalline, crystallized and in coarse cleavage masses. Where it occurs freely crystallized, as in vugs, it most commonly takes the shape of double-ended scalenohedra, but sometimes exhibits the prism terminated by faces of the rhombo-

Quartz. Barite. Calcite.

hedron. Mr. H. P. Brumell, who applied the alcohol flame test to a large number of specimens of this mineral from this district, reports finding strontium in nearly all.

Fluorite. The fluorite occurs granular, crystalline, crystallized and in mammillated forms, whose surfaces are often made up of faces of the cube. When crystallized, it occurs in well-formed cubic crystals or in groups of the same. Its color is most commonly light-green, but it shows amethyst tints nearly as often, whilst some of the layers of green fluorite show a tendency to this amethyst color on their mammillated surfaces. Occasionally, detached, well-formed crystals, occurring in *vugs*, are pale yellow or colorless.

Chloritic, etc. The description of the saponite has been given in mentioning its occurrence at the *Beaver Mine*, and the presence of chloritic material has also already been alluded to. This latter, although not part of the veinstone proper, is yet of frequent occurrence, and its very dark-green or almost black, soft varieties have been occasionally mistaken by prospectors for plumbago, which is considered a favorable indication in the district. The association of this latter mineral, and the occurrence of other forms of carbon in connection with these veins, has already been mentioned at several places, and the favor with which it is regarded as an indication arises from its close association with the rich ore of *Silver Islet*. The anthracite-resembling form which is occasionally found in the veins, as well as in the enclosing rocks, would seem in composition to be almost pure carbon, showing, as it does, no volatile matter on being heated. It has been described as altered bitumen in the "Geology of Canada," 1863.

Carbon.

Water and gas. An analysis of one of the mineral waters has already been given in speaking of *Silver Islet*, so that no more need be here said regarding them, except, that if the managers of the mines could be induced to collect samples, further examinations might give interesting results. Of the gas we unfortunately know nothing, except that it is inflammable. I was never fortunate enough to be present when any was met with, but explained to some of the managers how it might be collected, thinking that a preliminary examination of such a sample might be of use, but my efforts to secure some have so far been in vain.

This completes the description of the non-metallic contents of the veins, the characters of the metallic minerals being given below, dealing with them in the order of their prevalence. The blende comes first in importance, being the most plentiful. It occurs both crystallised and in cleavage masses, often of considerable extent. It is sometimes disseminated through the gangue, and often forms solid ribs, etc., traversing it. It frequently occurs thus along the walls of

Blende.

the fissures, and as crystalline growths starting out from them into the veinstone. It shows both lighter and darker coloured varieties, the former more often as detached disseminated crystals, whilst its more massive occurrences are generally of a very dark brown colour or almost black.

Galena. The galena does not play such an important part, nor generally exist in such considerable masses, but is generally disseminated. It also shows sometimes as films, sheets and little patches in the jointings and cleavages of the veinstone, which, from having a dull, leaden surface and dark color, somewhat resemble similar occurrences of argentite, from which they can be readily distinguished, however, by cutting with the knife, when they break up into little grains showing the characteristic bright cleavage surfaces of galena. Both the blende and this mineral are often found in the *vugs* and open spaces in the veins, in beautifully perfect crystals, the latter showing most commonly in combinations of the cube and rhombic dodecahedron.

Pyrite. The pyrite is found to a lesser extent than the two last mentioned. It occurs often well crystallised in small cubes coating the crystals of quartz or calcite, which are found lining *vugs* and also disseminated in the gangue and to a less extent in films and dendritic markings in the jointings and cleavages of the gangue minerals. It is also found sometimes in the rocks of the district, especially in the trap, but sometimes in the argillites, cherts, etc., and occasionally in considerable quantity adjacent to some of the veins as at the *3 B* vein, on Big Trout Bay.

Other metallic minerals. Besides these more important metallic minerals, others are found in connexion with them, viz., marcasite and pyrrhotite, which are, however, rather rare, whilst copper is represented, especially in the Coast Group, by chalcopyrite and copper-glance, the latter being often argentiferous.

Occurrence of the silver minerals. So much then for the metallic minerals which form the associates of the silver minerals proper: the mode of occurrence of the latter will be now described. In the ore bodies, the metallic minerals are generally present in large quantity, blende generally predominating largely, although galena sometimes plays a prominent part, and through these minerals are found distributed the argentite and native silver. Sometimes these silver minerals are distributed through the gangue minerals themselves, the others being hardly represented at all. The argentite which is the most common is found in nuggets of various sizes in the *vugs* bearing the impress of the quartz or calcite crystals which usually line them, and also in thin films coating the surfaces of such crystals, and in the joints and cleavages of the gangue

minerals, whilst it is also occasionally recognisable in the cleavages of the blende. Where filling in larger cracks, it, of course, occurs in thicker sheets, whilst at times, when very thinly distributed over cleavage planes, it assumes dendritic forms. Sometimes these films are found to merge at places into the native metal as if from a partial reduction of the sulphide. It is sometimes stated in the district that it occurs in the argillites themselves, but in these cases it is always found to be in thin joints and cracks in them. The native silver occurs in thin sheets, films and facings in a similar way to the last and also in wire and fern-like forms, the latter in *vugs* at times forming a very beautifully moss-like lining to them. In one or two instances these wires etc., were found seemingly penetrating small crystals of blende, or as if that mineral had crystallised around them. With the exception of *Silver Islet*, this form of silver seems to be more characteristic of the ore bodies near the surface and to be replaced by argentite in depth, which would seem to show that it is probably due to the reduction of that mineral to the metallic state by surface waters.

Native silver.

Dendrites.

Besides the dendritic occurrences of argentite, other dendritic films and stains are common in the cleavages and jointings of the veinstones. These have often been mistaken by prospectors for argentite, but to the experienced eye, whilst greatly resembling it, they have yet a distinguishable difference of colour and lustre. In composition they are probably oxides of iron or manganese.

Results of assays made.

Assays have been made in the laboratory of the Survey, to the number of about forty-nine, of specially selected specimens, with a view to get some further knowledge as to whether or no the other metallic minerals carry the precious metals. These specimens were selected on account of their holding as large a proportion as was obtainable of the metallic minerals, and where possible, which was seldom however, these different metallic minerals were obtained free from admixture with each other.* A careful record was kept of the mineral contents of each one submitted for assay and the study of these in connection with the results obtained point to the following conclusions, viz:—that the metallic minerals when free from visible silver compounds, carry none of that metal, or when they do so, its proportion is very small. The likelihood of their carrying any silver seems to be in the order in which they are here named, viz:—blende, galena and pyrite, only one instance being found in which the latter mineral did so, where being the only one visibly present in the specimen of veinstone treated, the assay yielded about half an ounce of silver to the ton.

* See Reports of Geological Survey for 1886 and 18 7. Part T.—In nearly all the instances of specimens submitted for assay they carried enough of the metallic minerals to constitute good milling ore, had these minerals proved to contain as much silver as was credited to them in the district.

All the specimens were also examined for gold at the same time, but only showed traces of it in a few instances, and in those nearly always in specimens where the blende preponderated, pyrite being absent except in one instance, although one might have expected gold in connection with the pyrite considering its frequent association with that metal in gold veins proper.

As has been mentioned in connection with *Silver Islet* and the older mines, these metallic minerals or rather the galena and blende get enriched with silver in the ore bodies, and it has often been asserted that the very dark-coloured blende which so frequently occurs in this connection is always rich in silver, but some of the assays made prove that this is not always so. Of two specimens of such blende each accompanied by a little gangue, one showed no silver and the other gave about 337 oz. to the ton. In the latter instance, the attached gangue carried a little visible argentite, but not enough to account for so high a yield.*

Assays.

In the study of these assay results, no connection was noticeable between the different kinds of gangue in which the minerals occurred and the presence of silver. Further details of these assays will be found on referring to the reports of Mr. Hoffmann of the work of the Chemical Branch of the Survey for 1886 and 1887, and other assay returns of specimens from these veins will also be found scattered through similar reports in the volumes of the Survey for some years previous to this.

Relationships of different vein. Materials

A much closer and more extensive study than the time at disposal has allowed of, would be required to determine the relationships of the various minerals to each other, and whether they all owe their presence to the continuous action of one set of forces, or whether they have been formed at different periods. So far as the study has gone, however, some suggestive points have been made out. For instance, the presence of the films of silica deposited in the cleavage planes and minute fissures traversing calcite would seem to prove that quartz must have been infiltrated after the calcite had been formed, whilst in other cases, these minerals are found so related to each other that they would seem to have been formed about the same time, which is probably due to the existence of quartz of two different ages, one deposited later than the other. There are some similar evidences of the presence of both primary and secondary calcite, the latter kind showing in the *vugs* as finely formed small transparent crystals, generally scalenohedra, but sometimes a combination of prism with rhombohedral terminations. These are there superimposed upon minerals which are otherwise

Primary and secondary quartz and calcite, etc.

* See Report of Geological Survey of Canada for 1887. Part T Assays 35 and 36.

generally found coating the other kinds of calcite whose coarse cleavage masses and opaque white appearance contrast strongly with the characters presented by the secondary forms.

Probable mode of deposition of silver minerals. The mode of occurrence of the silver minerals, too, would seem to show that their presence was due to a later infiltration of silver-bearing waters subsequent to the deposition of the gangue minerals; occurring as they do, deposited in the fissures which traverse these, in the cleavage planes of the calcite and coating crystals of silica, etc., and as one would expect forming larger masses or nuggets in the wider spaces or *vugs* in the vein. This deposition seems to be confined to the permeable minerals and parts of the gangue as might be predicted, and I cannot recollect seeing the silver compounds actually in minerals such as quartz or barite which are evidently not adapted to this method of enrichment. It would also be in keeping with the facts noticed regarding the other minerals; the compact pyrites not being argentiferous, whilst the presence of cleavage planes in blende would allow of its enrichment in this manner at points where such deposition was going on. It is also noticeable that, so far, no instance has been observed of the secondary calcite carrying silver in this way. Mr. Courtis records a curious association of minerals which he observed at *Silver Islet*. He says:—"The breast of the stope showed a coating several inches thick of a spongy silver in which were imbedded, like plums in a pudding, double-ended quartz crystals."*

Possible sources of silver. Many suggestions have been made by various observers as to the probable source whence these silver minerals have been derived. Some have thought them to be due to the same volcanic action to which are attributable the presence of the traps in the formation, and that the silver has been brought up by thermal waters accompanying these intrusions, but, as the fissures intersect and dislocate the trap sheets and dykes equally with the other rocks, the former must have been formed and solidified long before the fissures. The fact, however, remains that all the ore bodies found so far, occur near or within a reasonable distance of trap in some form, either in dykes, as in the case of the Coast group, or in sheets, as with the other groups. This suggests the idea that the silver may be derived from them by decomposition of some of their mineral constituents carrying minute quantities of silver, by waters infiltrating downwards through all their joints and pores, and that these waters passing onwards and soaking into the permeable parts and minerals in the gangue of the veins, have there deposited their silver contents, the various forms of carbon present in the sedimentary rocks having had some influence in effecting this precipitation. The presence

*See Transactions American Institute of Mining Engineers, Vol. XV, page 674.

of the soft talcose and of the various chloritic materials in this connection would seem to bear out this assumption, as they are just such decomposition products as would result from this kind of action. The most favourable conditions for the production of such results then would be :—1st. Such a combination of mineral and physical characters of the gangue as would render it easily permeable. 2nd. The presence of carbon in some form. 3rd. The presence in the adjacent trap of the silver-bearing constituent, and also of a jointiness and fissuring allowing of the infiltration of the decomposing waters. In this way we would expect more effect from the very jointy, columnar and more extensive sheets than from the more compact and less extensive ones. Thus, it would be only where all these conditions were combined, which would only be at spots, that the deposition of the silver minerals could be expected to take place, a view that goes far to account for the mode of occurrence of the rich ore in the veins in detached bunches varying much in size and frequency, and for the total absence of silver in the intermediate stretches of the veins, as well as for the curious fact that the metallic minerals carry no silver remote from the rich parts. Probable conditions of deposition of silver minerals

Movements subsequent to the formation of the veins (of which there is some evidence at places) would also tend to produce favourable conditions by fissuring and rendering the gangue minerals more permeable. These hypotheses might be held, by those who have the idea that the trap forms a single flow or sheet at a definite horizon in the formation, to necessitate the conclusion that the ores would be found only near the surface, but when we remember that this is not so, and that the trap sheets exist at various horizons all through these rocks, it will be seen that no basis for such an assumption exists, and that they are just as likely to be found in depth as at the surface. The above hypotheses must, of course, be only taken as suggestive, as there are yet many gaps in the evidence and points yet open for study, one in particular as to whether the traps do or do not contain any silver, a point that can, of course, only be settled by an extensive series of carefully made assays of these rocks, such as have been made in investigating similar phenomena at other places.

Conclusion.

In concluding this study of "Silver Mining on Lake Superior" from the standpoints enumerated in the preface, the results may be summarized as follows :—

Part of the area of the Animikie or silver-bearing rocks in Canada has been fairly prospected, although not nearly so thoroughly as it might, and probably would have been, but for certain adverse, economic Extent of silver formation explored.

General results of explorations.

conditions previously mentioned. This search has led to the discovery of very many veins, some of which have been proved by development to contain extensive bodies of very rich silver ores. A great many of the other veins found have also yielded smaller quantities and specimens of similar ore, whilst in a great many none has been found so far. In the two latter cases, however, it generally appears on investigation, that the work done to test the veins has been so slight as to leave the question of their capabilities as ore-producers still unsettled, which also applies to many of the mines which were opened during the earlier periods of the history of the district and are now closed. In these, although much more was done than mere surface testing, and although shafts, etc., were sunk, still these underground developments were in most cases not sufficiently extensive to disprove the existence of ore bodies of sufficient extent and frequency to pay.

Results of prospecting and developement of silver veins.

Amongst the chief results of all this prospecting work have been: the proving of the widespread occurrence of rich silver ores throughout the formation, and the existence of very numerous veins, on very many of which, if properly handled, successful mines, besides those already in operation will be opened up. Of course, many of them may not thus reward the efforts made to develop them, but this is no more than occurs in every mining district in the world, and we cannot expect the one under study to prove an exception.

Lessons taught by past experiences in the district.

One of the most important lessons taught by past experience is, that owing to the mode of occurrence of silver in the veins, they require more extended underground developments to prove their value than most other lodes, and that unless this is borne in mind and acted upon in the future, and unless the developmental works and drifts are kept well ahead of the stoping out of the ore bodies already found, and the operating companies provide in the start a sufficient capital to do this, the failures of the past will be repeated in the future. Regarding the statistics of the yield of silver from this district further details will be found in the article on silver by myself in the Report of the Geological and Natural History Survey of Canada for 1886, Part S, pages 73-5.

APPENDIX I.

NOTES OF MICROSCOPICAL EXAMINATIONS

OF

ROCKS

FROM THE

THUNDER BAY SILVER DISTRICT.

BY MR. W. S. BAYLEY

OF

THE JOHNS HOPKINS UNIVERSITY,

Baltimore, U.S.A.

No. 85.—McKELLAR'S POINT (*from near the end*). This rock is composed of felspar, quartz, green hornblende and magnetite. The felspar is in rudely outlined lath-shaped crystals, and in irregular grains between the other constituents. It is very much altered, and as a result of this alteration, is filled with inclusions of red iron compounds. These are scattered throughout the material of the crystals and grains, but are most abundant around their exterior portions. Kaolin and chlorite are the remaining products of its alteration. The quartz occurs in irregular areas and in club-shaped masses, intergrown with portions of the red felspar. The green hornblende is only sparingly present. It is found in little plates and shreds, and in allotriomorphic grains between the other components. It has undergone chloritization, resulting in the breaking up of the grains into small particles and fibres which are irregularly intermingled with the felspar and quartz. Magnetite is closely associated with the chlorite derived from the hornblende. It is also occasionally present in little grains in the felspar. In the latter case it is sometimes surrounded by rims of brown biotite. Apatite and sphene (?) also occur in small quantity.

Microscopical characters of rocks of silver formation.

From the examination of this single specimen it would seem necessary to regard the rock as closely allied to those of Irving's augite-syenites,* which are like the contact rocks on Pigeon Point,† at the junction of olivine-gabbro and an acid eruptive.

* Copper-Bearing Rocks, p. 112-125, Pt. XIV.

† Amer. Jour. Sci., Jan. 1889.

Microscopical characters of rocks of silver formation—continued.

No 113.—Jarvis Island (*from North of Shaft*). In number 113 the original structure of the rock is still preserved. Very much altered lath-shaped crystals of plagioclase lie in a mass of red felspathic substance and secondary quartz. The quartz is either in little club-shaped masses filling the angular cavities between the large plagioclase crystals, or is in micropegmatitic intergrowths with the red felspathic substance. Wedge-shaped aggregates of chlorite, brown mica and green horn-blende, in the midst of which are often to be detected little areas of augite, leave no doubt that the latter mineral was once an important constituent. Apatite, magnetite, pyrite and a few plates of hematite are the remaining components.

The rock is evidently a much decomposed diabase. Its characteristics are very similar to those of diabases which have suffered alteration as a consequence of their penetration by solutions emanating from masses of acid eruptive rocks.

No. 128.—Jarvis Island (*from North Side of Shaft*). Number 128 appears to be a rock whose characteristics are intermediate between those of No. 85 and No. 113. The outlines of the felspars can be detected only in rare cases. The quartz is present in those forms usually resulting from a secondary origin. Green hornblende is more abundant than in either one of the two rocks described above and is not infrequently possessed of its own crystallographic outlines. Only the minutest traces of augite can be discovered. Magnetite is more abundant than in the first two rocks, and is usually in rod like forms. A little apatite, leucoxene and secondary brown mica are also present.

The nature of the rock is probably the same as that of Nos. 85 and 113, i. e., it is was originally a diabase, which has been altered in the same way as has the gabbro in Pigeon Point, at its contact with an acid eruptive rock.

No. 127.—Jarvis Island (*altered argillite*). This rock is quite different from either one of the others described. It is probably an altered slate or argillite. The least altered portion of the section examined consists of quartz, felspar and chlorite, with a few other subordinate substances. Its structure is that of a typical phyllite.

In the more altered portion, the felspar is bounded by traces of crystal outlines. It is red through the inclusion of little plates of hematite, and can occasionally be detected with twinning lamellæ. The green mineral corresponding to the chlorite in the least altered portions, is here grouped into little sheaves of fibres, which, between crossed nicols, give bright polarization colors. It has been changed into a micaceous substance with many of the properties of green biotite.

In its original state the rock was probably a slate, which under the

influence of some eruptive mass (probably of the composition of No. 85 or 113) has recrystallized, with the addition of felspathic substance derived from the eruptive which produced the recrystallization.

Microscopical characters of rocks of silver formation—continued.

Of the Following Thirteen Specimens, the Slides were Received from Mr. E. D. Ingall.

You will notice the three traps (Nos. 259, 301 and 338) are, as you intimated in your note, very similar, and are probably parts of the me great flow. They differ merely in state of preservation.

The granite (No. 277) possesses peculiarities which distinguish it from ordinary intrusive granite. The pressure phenomena show that it has undergone considerable change since it was first produced. It would be supposed that as a consequence of this pressure, schistosity would have been induced. The specimen sent me is too small to distinguish this structure, if it does exist. The question whether the rock is metamorphic or intrusive will have to be left for you to decide. As a result of the microscopical examination, it would be most natural to suppose that the rock (whatever it may have been originally), was subjected to pressure after the present minerals had been formed, otherwise the structures observed would be impossible to explain. Whether the same causes first produced the rock and then by further action produced in it these pressure effects, is difficult to determine. While the question as to the origin of this rock is not positively decided, it would, I think, be safe to say that it is probably of metamorphic origin.

Nos. 259, 301 and 338 are all typical traps, e. i. are diabases, more or less altered. Of these, No. 338 is the least changed.

No. 338. Palisades.—This is a medium-grained diabase, with the typical diabase structure. It consists of lath-shaped crystals of twinned plagioclase in a ground mass composed almost entirely of augite. The plagioclase is fresh in part, when it is almost glassy in appearance, and possesses very well defined twinning lamellæ. The angles of extinction measured against the line of union between contiguous lamellæ indicate that the predominating variety is labradorite.

Most of the plagioclase, however, has undergone alteration, and has thus given rise to secondary products, the most important of which are calcite and chlorite. The former occurs in very small quantity, and is found in little irregularly shaped grains near the periphery of the felspar crystals. The chlorite penetrates the plagioclase substance in little veins, and is also found around its edges.

Microscopical characters of rocks of silver formation—continued.

The augite is of a very light wine color. It fills in the interstices between the felspar. When fresh, its cleavage is very perfect, the section seemingly being made up of little square blocks of augite. In most cases, this mineral has undergone considerable change. Chlorite and a yellowish green aggregate of an earthy substance have taken its place.

In one or two instances, a yellowish substance, consisting of an aggregate of little fibres, looks very much like serpentine, which has been stained yellow by iron salts. It may be due to the alteration of an original olivine constituent. Magnetite in grains, apatite in long, slender needles, and a little leucoxene, occur as accessory minerals.

No. 301. SILVER BLUFF, R. 61 (*Trap from six inches above contact*), is not quite as fresh as 338, nor quite as much altered as 259.

Little cores of augite can be detected in the abundant chlorite which makes up the greater part of the slide. The magnetite, instead of existing in little irregular grains scattered among the other constituents, occurs in skeleton crystals, as is frequently the case in basalts.*

No. 259. CROWN POINT (*Trap from above tunnel*) is a tolerably fine-grained, much altered diabase, in which the original structure can still be very readily discerned.

The felspar occurs in lath-shaped crystals, with very ill-defined outlines. These crystals often contain so many inclusions of various kinds, and are frequently so much altered, that they are in some cases almost opaque. Chlorite, mica and calcite are the predominating products of alteration. Where it could be measured, the angle of extinction in this felspar was very small, thus indicating oligoclase, as the principal felspathic constituent.

The augite, which originally filled in the spaces between the felspar crystals has almost entirely disappeared, and in its place there is found a yellow mixture of chlorite and another mineral of a finely fibrous structure. The pleochroism of the chlorite is scarcely perceptible, and the polarization colors between crossed nicols are extremely weak. Rutile and leucoxene usually accompany these secondary products as inclusions, and a very small amount of secondary brown pleochroic biotite is not uncommon around the edges and in the interior of the aggregates.

Large crystals of very light green apatite and considerable magnetite are scattered throughout the rock, the latter being often surrounded by a rim of biotite. The similarity between these three slides is so great that they may well (as far as the microscopic examination goes) be considered as sections of rocks which originally formed part of the same "flow."

*Rosenbusch: Mikroskopische Physiographie I, 1885 Stuttgart. Taf. III., Fig. 2.

No. 277. WOODSIDE'S (*Granite*) at first sight appears to be a typical granitite, very much like the Huronian granite of the Wisconsin Survey. A closer examination, however, shows it to possess characteristics which serve to distinguish it from most of the granites heretofore described as existing in this neighborhood. Almost the only constituents are quartz, orthoclase, plagioclase and chlorite. Microscopical characters of rocks of silver formation—continued.

The quartz is clouded with inclusions of red and green earthy substances, little folia of chlorite and hematite, and is particularly rich in liquid inclusions containing movable bubbles.

The orthoclase is clouded in consequence of its alteration. The principal product of this alteration is kaolin, though frequently scales of chlorite are quite abundant. By far the greater proportion of the felspar is triclinic. This triclinic felspar seems to be of three distinct kinds:—1. Microcline, with its twinning lamellæ, crossing at angles of 90°. This is very fresh and glassy, and contains almost no inclusions. 2. A plagioclase, with tolerably broad twinning lamellæ. This has suffered alteration to a considerable extent. For reasons which will be mentioned hereafter, its extinction could not be measured. 3. Another plagioclase, with broad twinning lamellæ, the extinctions of which it was impossible to measure, in consequence of the great amount of change which it has undergone. The twin structure in many cases could only be detected after very careful search.

The chlorite is evidently the product of the alteration of biotite. It possesses all the characteristics of chlorite which has been thus developed. The original structure of the mica is preserved, and in not a few cases, traces of the biotite can still be detected.

The most interesting point in relation to this rock is its structure. All the constituents look as if they had been crushed. Their contours are not as regular as in the case of most granites. On the other hand, pieces of one mineral seem to have been shoved into the others. The chlorite occurs in very thin plates between the felspar and quartz, as if it had been squeezed by great pressure.

The most undoubted evidence of pressure, however, is the existence in the plagioclase of a very well marked cleavage, in most instances as well marked as in the case of calcite. In one piece of microcline, while the centre was to all appearances compact, the edges possessed very sharp cleavage lines, cutting each other at angles of 82° 83°. In addition to this, almost all the twinning lamellæ are bowed and twisted, just as in the case of the plagioclase in the gabbro of Penig.* For this reason, as mentioned above, exact determinations of the plagioclase were impossible. In addition to the original twinning, a secondary twinning was often observed, as a consequence of the action of pressure.

* Lehmann: Entstehung der altkrystallinischen Schiefergesteine, etc. Taf. C., Figs. 1 and 4.

Microscopic characters of rocks of silver formation—continued.

No. 281. R. 64. LOCATION (*Chert*).—This rock is composed in greater part of what were originally round and irregular pieces of felspar, in a ground mass of quartz. The felspar has for the most part been entirely replaced by its various decomposition products, viz., calcite, chlorite and hydrated iron oxides. That portion which has not undergone this alteration has been completely replaced by silica, so that round, cloudy areas of silica (principally in the form of chalcedony) now appear where originally felspar existed. These pseudomorphs are usually marked by a rim of green or red color, probably due to chlorite and iron oxide, which separated out either previous to or coincident with the silicification process. Immediately outside of these rims there is deposition of chalcedony, which forms a feathery periphery extending from all sides into the interstices between large quartz grains, which in turn form a mosaic in the centre of the spaces between the original grains of felspar.

Scattered through the slide, both in the larger grains and also in the interstices between these, are little cloudy, almost opaque, areas, which under crossed nicols, resolve themselves into calcite. The centres of these little areas are dark and structureless, while the outer portions are composed of the perfectly crystallized mineral. This calcite has every appearance of having been enlarged, after it had once been formed, by the addition of new material around the opaque portions in a manner analogous to the enlargements of quartz grains, so distinctly shown by Profs. Irving and Van Hise, of the United States Geological Survey.

The present condition of the rock seems to be due to a very thorough process of silicification.

No. 303. SILVER BLUFF, (R. 61)—(*About fifty feet below contact.*) Is of the same general nature as the above. In this, however, the calcite occurs with chlorite and other alteration products of felspar to form complete pseudomorphs of this mineral. Round and angular grains consist now of chlorite and crystallized calcite, mixed with magnetite (which is usually found around the edges of the grain), and a brown earthy substance. The outlines of the original grains are well preserved by the rim of magnetite, but their material has entirely disappeared. From the large amount of magnetite and other iron minerals present in the slide it may be doubted whether the original grains were not augite or some other iron-bearing mineral.

A few grains are composed entirely of silica, as in the case of section 281.

The interstitial silica in this slide differs from that in 281 in that it is present on ly inthe form of a mosaic of quartz grains.

No. 302. SILVER BLUFF, (R. 61)—(*Top of beds close under trap sheet.*)—This rock is very remarkable. If it was ever a chert, it has undergone such deep-seated alterations that every vestige of its original nature has entirely disappeared. Microscopic characters of rocks of silver formation—continued.

Under the microscope, it is seen to consist of a granular mass of a pale yellow mineral, highly refractive, weakly pleochroic and possessing between crossed nicols bright polarization colors. This mineral, probably epidote, is intermingled with long fibres of a very light colored hornblende, pleochroic in yellow and light green tints, which, together with a little chlorite and a few quartz grains, constitute the entire rock. It seems probable that the overlying trap may in some way have given rise to this very peculiar rock.

A chemical analysis would probably reveal interesting results.

No. 317. R. 93 RIDGE—(*Middle bed of ridge.*)—Like the last rock described, this appears to be a much altered chert. So very much altered is it that a description of its microscopical characteristics is almost impossible.

Little pebbles of various kinds are included in a ground-mass of quartz grains and a black earthy material, with some magnetite. Scattered through this ground mass are numerous needles of a greenish hornblende, which in some instances are so aggregated as to form little areas, which at first glance seem to have the form of a grain which they have replaced. Upon closer examination they are seen to be merely accumulations of fibres.

In some portions of the slide, little lath shaped crystals of plagioclase and acicular crystals of hornblende occur in a ground-mass of hematite. In these portions the structure is very similar to that so common in diabases.

No. 318. R. 93 RIDGE—(*Bottom bed of ridge.*)—Of this rock very little can be learned from the section. It is so badly stained with ochreous material as to be for the most part opaque. Occasionally a little grain of a highly refractive mineral can be detected. This is usually fibrous, and sometimes possesses an extinction angle very near that of augite. Grains of epidote can also be detected.

No. 319. R. 93 RIDGE—(*Top bed of ridge.*)—This section also is so clouded with magnetite as to render its microscopical examination almost worthless. Bands of black earthy material, containing a large quantity of magnetite, alternate with bands of brightly polarising material in fibrous forms, which under a high power are resolved into grains of epidote and fibres of hornblende.

A little hematite and some chlorite complete the list of minerals which can be determined in the section.

Microscopic characters of rocks of silver formation—continued.

The several bands are arranged in such a manner as to suggest the flowage structure of felsites, rhyolites and obsidians.

No. 320. R. 93 Ridge—(*Upper beds of ridge.*)—Is another very peculiar and interesting rock. It consists of alternate bands of small crystals of augite, perfectly fresh and unmixed with any other materials, and other bands containing considerable uralitized augite, mixed with plates and needles of a light green hornblende, with many of the characteristics of actinolite. Fine fissures extend into the rock in a direction approximately parallel to the bands. On both sides of these cracks the minerals are stained with a brownish-red ochreous material.

I know of no rock just like this described in any of the journals. It seems to me very much like an aggregation of augite crystals in diabase, similar to the well known "Olivin-Knollen" of basalts.

No. 323. R. 93 Ridge—(*Trap sheet.*)—Is a well defined, fine-grained, altered diabase, very similar to many others described in Mr. Lawson's Report, and like No. 259 described for you some time ago. A great deal of the augite is still fresh and of a pale wine color. That which is no longer fresh is changed into a yellowish brown earthy substance. A little uralite and chlorite occur on the borders of some of the augite crystals, but in most cases both of these minerals are so colored by the ochreous material that their detection is not easy.

No. 325. R. 93 Ridge—(*Overlying cherty beds.*)—Is not very different from 303, except in the alteration of the rounded grains. In many cases, these consist of a very dark reddish-brown micaceous substance, mingled with a green mineral (probably of the serpentine group) and reddish-brown iron hydroxide. In some of the lighter colored grains, the remains of a colorless augite can readily be detected.

In other cases, the entire substance of the original grain has given place to silica in the form of a fine mosaic of quartz. In these, the outline of the original grain has been rendered permanent by a line of little plates of brown mica.

As in 303, the interstitial substance is quartz. Around the edges of the separate grains, crystals of quartz extend out on all sides, like the lining of a vein. Where the space between the fragmental grains was small, the two rows of quartz crystals mutually interfere and completely fill the spaces; where the intervening space was large, that portion in its centre between the rows of crystals is filled by a mosaic of the same mineral. Cracks which extend through the rock contain iron oxides or hydroxides.

APPENDIX II.

LITERATURE.

The following list includes all those works dealing with the subject of silver mining on Lake Superior, or embracing references to it, of which I have become cognisant since the commencement of the investigation.

The reference letters appended to some of them are those which have been used throughout the report to indicate the source from which each quoted item of information was derived.

Trans. Am. Ins. of Mining Engineers,	Volume ii, p. 89—W. M. Courtis.	(A)
Idem.	" v, " 473— Idem.	(B)
Idem.	" viii, " 229—Thos. Macfarlane.	(C)
Idem.	" xv, " 671—W. M. Courtis.	(G)
Eng. and Min. Journal of New York,	" xxiii, —W. McDermott.	
Idem.	" xxvi, —W. M. Courtis.	
Idem.	" xxxii, " 251—F. A. Lowe.	(E)
Idem.	" xxxiv, " 321— Idem.	(D)
Pamphlet on "Mining on the North shore of Lake Superior," 1874........	.... Peter McKellar.	(F)
Geol. and Nat. Hist. Survey of Canada, Report of Progress...........	1866-69, page 313—R. Bell.	(H)
Idem.	1872-73, " 108— Idem.	(I)
Idem.	Various assay returns included in yearly reports of Chemical Branch.	
Can. Naturalist, 2nd Series (Paper on "Geology and Silver Ore of Wood's Location, Lake Superior"—Silver Islet)............................	Volume iv, p. 37—Thos. Macfarlane.	
Idem (Paper on Mineral Region of Superior)........................	" vii, " 49—R. Bell.	
Quar. Journal London Geol. Society (Paper on "The Geology of the Thunder Bay and Shebandowan Mining Districts of the North Shore of Lake Superior")................	" xxix, " 16—H. A. Nicholson.	

Milling of Silver Ores at the Silver Islet Mine.

The following figures are based upon official data of the *Silver Islet Mining Co.*, regarding the working of their mill during a period extending from May 6th, 1875, to October 31st, 1876.

Tons of rock milled				24,446
Result	1·853 %	"Concentrates"	453*	
	98·147 %	"Tailings"	23,993	
	100·000 %			24,446

Average yield of bar Silver (999 fine) per ton of rock milled	8·33 ozs.
Average loss in "Tailings" per ton of rock milled	1·53 "
Original Silver contents of mill rock per ton	9.86 "
Average Silver contents of "Concentrates" per ton (200 lbs)	449·42 ozs.

Cost of working; calculated to the ton of rock milled:—

Transport; Islet to Mill	$0.50
Stamping and Concentrating	1.97
Freight and Insurance on "Concentrates" to Wyandotte and expressage on bar Silver to New York	0.35
Smelting and Charges; Wyandotte	2.08
Total cost per ton of rock	$4.90

* "This was the 'dry weight;' although the Assay for moisture was so imperfectly done about 4 p. c. of the Silver was lost."

MINES AND MINING ON LAKE SUPERIOR.

PART H. ANNUAL REPORT, 1887.

By ELFRIC DREW INGALL, M.E.,

Associate of the Royal School of Mines, Mining Geologist to the Geological Survey of Canada.

SUPPLEMENTARY REPORT

TO

PART I.—B. SILVER MINING.

Since the completion of the report on Silver Mining, above mentioned, work has continued to be actively prosecuted in the Thunder Bay district. Information respecting this work has been received from time to time, and is given below. Details on the progress of development in this district up to the end of August, 1887, will be found in Part S, Annual Report for 1887. Recent developments Thunder Bay Silver Mining District.

The chief points of activity S.W. from Port Arthur have been at the Beaver, Badger and Rabbit Mountain Mines, and further W. at the East and West End Mines of Silver Mountain, the former being also known as the Shuniah Weachu Mine.

Besides the mines mentioned, however, many others have been operated on a smaller scale, with the object of proving various veins. Prospecting for new viens has also been actively carried on, chiefly in the western districts around Whitefish Lake.

Rabbit Mountain Mine.

The working of this mine was continued with more or less vigour during the year 1887, but operations were suspended on the 16th of December in that year.

From information received from Mr. Michael Lynch, who was underground captain at the mine, it appears that the measurements of the workings at the time of cessation were as follows: No. 3 level E. from No. 2 shaft, 160 feet; No. 3 level W. from the same, 85 feet; No. 4 level E. from No. 2 shaft, 85 feet, and W. from the same, 30 feet.

Recent developments Thunder Bay Silver Mining District.

No. 2 shaft has been sunk to a depth of 355 feet from surface. The other workings had remained as shown in the illustration (see plate VII., fig. 2.)

According to reports received from time to time, rich ore seems to have been obtained in sinking No. 2 shaft, for, besides that mentioned on p. 70 H. as having been observed at the 2nd level, it is asserted that for the last 100 feet of the shaft rich ore was continually met with. It has not been ascertained why work was suspended at this mine, which is still idle.

Porcupine Mine.

The necessary financial arrangements not having been made for the commencement of the work on a large scale at this mine, there is little to add to the description given in the body of the report, except to record the discovery of another vein in the vicinity of the original one, about 400 feet S. of and running parallel with it. Sufficient work has not been done on this vein to ascertain its dip, but it is considered by the owners to be to the N.W., as they find the trap to be lower on that side from the faulting effect of the fissure.

Beaver Mine.

Since the last visit made to this mine in the fall of 1886, during the prosecution of the field work for the main part of this report, a large body of rich ore was discovered, particulars of which are given in the Report on Mining and Mineral Statistics for 1887, Part S of the volume for that year and by many others, notably by Dr. Lawson of the staff of the survey who, in a letter addressed to the Director, describes it as follows :—

"I was in the mine last October, and was at that time not favorably impressed with the lead, and went last Saturday prepared to meet with the same experience, but this time I was very agreeably surprised. They are working the mine by adits run in from the face of a steep hill and by shafts from the top of the hill. The lead when observed by me last fall was very lean and unprofitable, and did not show any signs of becoming richer till some time in March, and the management of the mine were so discouraged that they were on the point of giving it up and abandoning the enterprise. They persevered, however, and in March or April the lead suddenly expanded from a mere stringer or series of stringers to a wide and exceedingly rich vein of magnificent ore. I was afforded a good opportunity for close inspection for over a whole day. There are many hundreds (I may safely say more than a thousand) tons in actual sight of rich ore which will yield 100, 200, 500 up to 800 and 1000 ounces to the ton.

"I am sure that the owners of the mine have struck a bonanza, and am very glad indeed, that their enterprise has been rewarded. What the limits of the body of rich ore are I am unable to say, as there is no engineer on the property to give data for an estimate, and no very recent survey of the mine showing the relation in space of the different parts of the drifts and shafts. If you desire it I could make a survey of the mine and give you more detailed information. At its best the vein runs from three or four to five or six feet in width. The gangue is soft, being mostly calcite with some fluor spar and colorless or amethystine quartz, and through it all there is a soft, greasy material, said to be a silicate of magnesia, and called saponite by the people of the mine. This saponite appears to be a later infiltration but is often rich in argentite. Besides argentite there are native silver, sphalerite and galena. I send you by this mail a few specimens of the high grade ore. The specimens are not exceptional ones. * * * *

Recent developments Thunder Bay Silver Mining District.

"The mine may, on further exploitation of greater depths, prove even more valuable and become one of the remarkable finds in the history of mining. It will, I have no doubt, greatly encourage other mining enterprises in the district.

"(Signed) A. C. LAWSON.

"Port Arthur, June 6th, 1887."

The management have kindly furnished details of the extent of the workings completed since the compilation of the plan of the mine given in the report (see Plate VIII.) which can be corrected to March 10th, 1889, by making the below given additions.

No. 2 shaft; total depth from surface 385 feet. No. 1 level, below the adit, extends E. and W. from No. 2 shaft at a depth of 220 feet from surface measures, 550 feet W. and 200 feet E. No. 2 level below adit, at a depth of 320 feet from surface, extends 380 feet W. and 150 feet E.

No. 1 winze is sunk below the adit at a point 185 feet W. of No. 2 shaft, and had attained a depth of 280 feet connecting thus with the lower drifts. No. 2 winze connects the two above mentioned lower levels at a point 100 feet W. of No. 1 winze. No. 3 winze started below the No. 1 level below the adit at a point a 175 feet E. from No. 2 shaft, and had attained a depth of 50 feet. No. 4 winze, sinking below the same level at a point 460 feet W. from No. 2 shaft, had reached a depth of 60 feet. This, together with three cross-cuts made at points along No. 1 level below the adit, viz., at 300 and 370 feet W., at 40 feet E. of No. 2 shaft, completes the description of the exploratory work done to that date.

Recent developments Thunder Bay Silver Mining District.

With regard to the ground stoped away, it would seem that, beginning at a point about 15 feet W. of No. 2 shaft to a point 300 feet W. of the same, the vein has been nearly completely removed above the adit level to within about 10 or 15 feet of the line of junction of the trap and argillite.

Badger Mine.

This mine was started since the completion of the report, and has attained considerable prominence, its development having been attended with very satisfactory results. A reference to the "sketch map" accompanying the report will shew the position of this mine and the strike or run of the vein which is said to dip S.E.

The work done to the 1st of January, 1889, is shewn on the accompanying section (plate X), which was kindly furnished by Mr. Chas. Brent, assayer at the mine. It also illustrates the relationships of the enclosing rocks, and shows that the geological conditions are similar to those of the other mines in the district, while the details regarding the nature of the vein, noticed by Mr. Coste (see vol. 1887, p. 94 s.), show it also to correspond with the other veins.

The official and other reports since received regarding the production of ore from this mine show a very large yield for the time it has been in operation.

Jarvis Island Mine.

This mine is at present idle, operations having been suspended in October, 1888. The following dimensions of the workings at this time are taken from a section of the mine kindly furnished by Mr. Arthur McEwan, formerly the superintendent:

Main shaft, 270 feet from surface. No. 1, level driven S. 230 feet, ditto N. 20 feet, with a small amount of stoping done above the end. The intermediate level between Nos. 1 and 2 extends N. of the shaft 50 feet, with a small amount of ground stoped out at the end. No. 2 level measures 236 feet S. and 90 feet N. from the shaft, with a small amount of stoping done above the N. level. At a depth of 238 feet a drift (No. 3) has been run 130 feet N. and 30 feet S. At a point 50 feet S. of the shaft a winze has been sunk below No. 1 level to a depth of 35 feet.

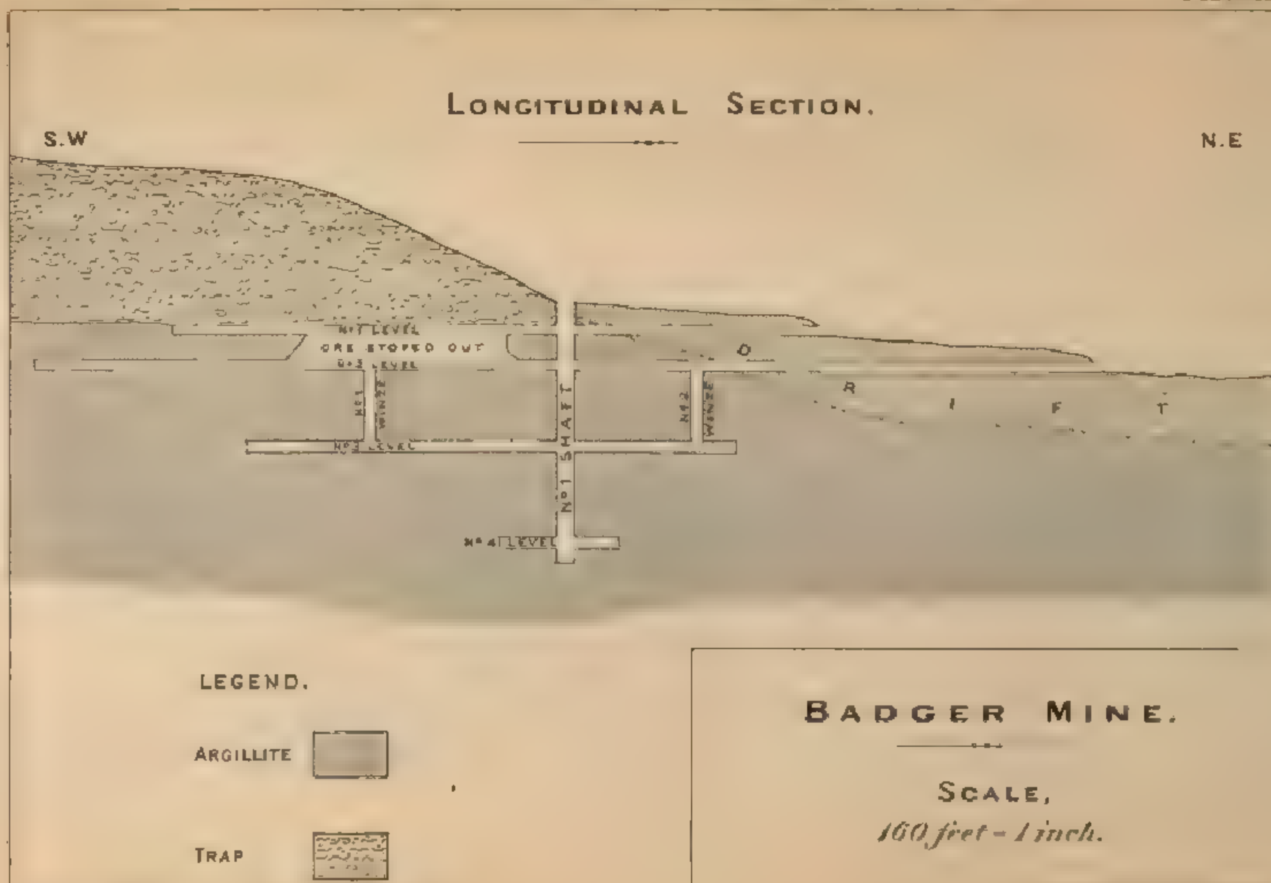
A reference to plate IV., figure 2, will make these details plain, and by adding them, the figure will then represent all the work done at the time of closing, with the exception of a certain amount of cross cutting in various parts of the mine.

The drawing referred to also shows shafts Nos. 2 and 4, the former 50 feet and the latter 95 feet in depth, with a drift S. from the bottom,

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR

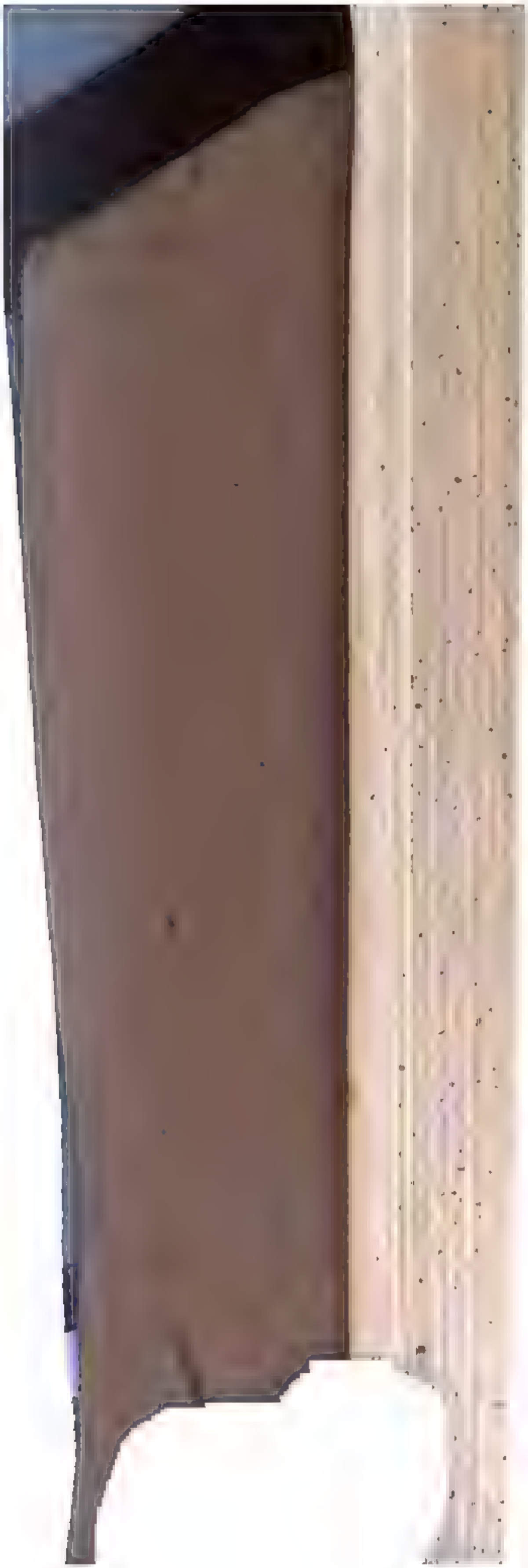
Plate X



Drawn by J. White.

G. E. Desbarats & Son lith. Montreal

SUPPLEMENT, MINES AND MINING ON LAKE SUPERIOR, BY E.D. INGALL, M.E. – PART H – ANNUAL REPORT, 1887.



Recent developments Thunder Bay Silver Mining District.

50 feet long, and a cross cut at the end. Another noticeable point is that the drawing would seem to show that the S. wall of the northern dyke was met with in the drifts S. of the main shaft at a distance of about 240 feet from the shaft, which does not at all agree with the surface evidence, and is probably a mistake due to the very altered condition of the argillites near the dyke, causing the rock to be mistaken for trap.

East Silver Mountain Mine.

Since the last visit made to this mine in 1886, work has been continuously prosecuted by the English company owning it, particulars of which to August, 1887, are to be found in Part S of the report of the survey for 1887, pp. 94-96. Of the work done since that date to December, 1888, particulars have been kindly furnished by Mr. Chas. M. Rolker, M.E., of New York, who then visited and examined the mine in the interests of the English shareholders. From the data thus obtained it would seem that the dimensions of the different workings were as follows, which will be understood by a reference to Plate IX., fig. 1:

No. 2 level, extended to 130 feet W. from No. 2 shaft. No. 1 level, extended to a point 590 feet W. from No. 2 shaft, which shaft has not been sunk any lower than No. 2 level, and does not therefore intersect No. 1 level. Above and below this level raises have been put up and winzes sunk at various point. Winze No. 1 (shewn in the section below "No. 4 pit"), sunk to a depth of 85 feet. Winze No. 3, at a point 320 feet W. from the last-mentioned, extends to a depth of 125 feet below this (No. 1) level. No. 4 winze connects No. 2 with No. 1 level at a point 100 feet west of No. 2 shaft. Measuring from this winze W. three "raises" have been put up from the back of No. 1 level, viz., at 100 feet W, a "raise" of 40 feet: at 300 feet W., a "raise" of 100 feet to the junction of the trap and argillite on the hanging wall of the vein, and finally, at a point 480 feet W., a "raise" of 25 feet. Besides this, Nos. 4 and 5 pits have been connected by a little drift, and ore stoped away around the latter pit to a depth of 45 feet from surface.

As mentioned in the report, No. 3 shaft is 820 feet W. from No. 2, and the dimensions of this part of the mine at the time mentioned were as follows: No. 3 shaft, 425 feet, but since sunk, it is said, to 465 feet from surface. No. 1 level, at a depth of 215 feet, driven W. from this shaft 230 feet, with a "raise" of 45 feet put up from the back of same at a point 75 feet in from the shaft.

No. 2 level, at a depth of 380 feet, extended to 125 feet east and 140 feet west, this end having, I understand, been since extended to 220 feet from the shaft.

Recent developments Thunder Bay Silver Mining District.

According to later information, received April 13th, 1889, work had been abandoned at this point, and another shaft (No. 4) had been started about 300 feet west from No. 3. This had been sunk ninety-five feet from the surface, and it is stated that from eighty feet to the bottom good ore had been encountered, consisting of argentiferous galena and blende, and said to assay from $80 to $150 per ton.

It would appear that small pockets of rich ore have been obtained at various places in prosecuting these workings, and it is said that a good bunch was encountered in No. 2 level, at a point about 120 feet west from No. 3 shaft, which is the more interesting in that the lower siliceous division rocks form the foot-wall of the vein at this point.

In the vicinity of a spot about 1000 feet north-east from the mouth of the lower tunnel (No. 1) a number of test-pits have been sunk to trace and prove two veins found there, which seem to be coming to a junction near this point. It is thought that one of them is the extension eastwards of the main vein from No. 7 pit (see plate IX.), whilst the other would seem to curve round to a more easterly and westerly course, and thus strike the bluff somewhere about 500 or 700 feet north of No. 1 shaft. These test-pits are on location R. 54, and are close to the lower limit of the upper division beds (see colored map accompanying the report), which are here, however, thrown slightly out of position by the faulting effect of the fissures. This junction-plane between the upper and lower division beds on the hanging wall of the vein has also been located in the main workings of the mine. At winze No. 1 it is met with at seventy-five feet below No. 1 level; at winze No. 3 at eighty-five feet, and at 135 feet below the same in No. 3 shaft, where it was also encountered on the hanging wall some fifty-five feet lower down, showing a very similar dip of the strata to the west, on the line of the vein, to that represented on the lower section, appended to the colored map accompanying the report.

According to Mr. Rolker's observations, with the fresh light thrown on matters by the recent developments, the lower surface of the trap rises slightly in going west, which, with the falling surface of the cherts, would show a slight thickening of the argillites in that direction, whilst the comparative horizontality of the surface of the ground would effect a thinning out of the trap sheet going west.

Recent work around this end of the mountain and the clearing in connection with it seem to have brought to light evidences of other faultings of the strata besides those found, and shown on the map, which is no more than one would expect, as doubtless all the vein fissures are accompanied by faulting to a greater or less degree, and it is not at all likely that they have been even yet all located, but rather that fresh discoveries of this kind will from time to time continue to reward searchers.

West End Silver Mountain Mine.

Recent developments Thunder Bay Silver Mining District.

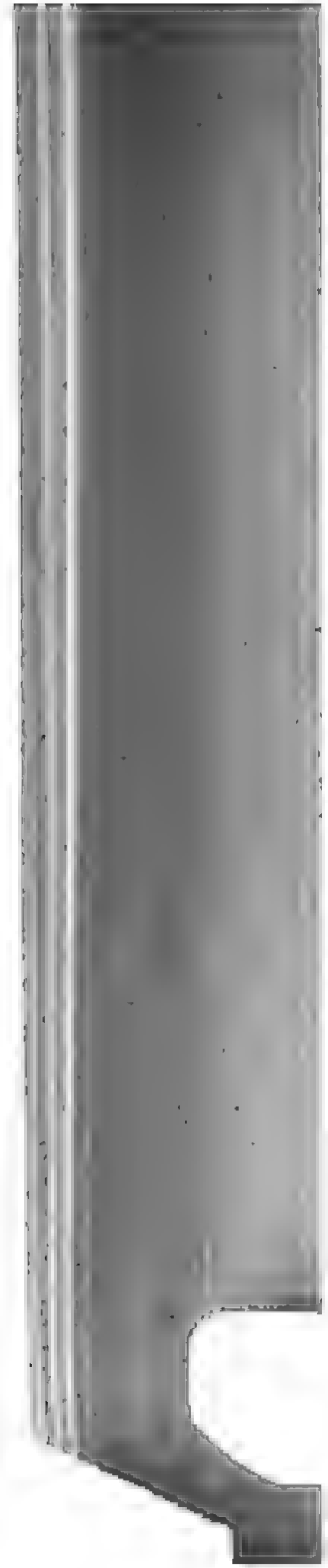
Work has been prosecuted at this mine for some time past, and it is still in operation, but particulars of the developments made have not yet come to hand. From latest reports, two shafts are being sunk, one close to the eastern boundary line of location R. 56, in view of the success being attained in that direction by the East End Company.

Other Workings.

Besides the above-mentioned, which constitute the chief centres of activity, exploration has been continued with considerable energy, and testing operations have been carried on at many points, but chiefly in the Whitefish Lake district. The most prominent are the Peerless vein of the Rabbit Mountain group, and on the Crown Point and Palisades veins in the Silver Mountain district, whilst westwards, around Whitefish Lake, a fair amount of development has to be recorded on the claims known as the Silver Wolverine, Queen, Silver Fox and Silver Tip, as well as on location R. 119, at Medicine Bluff, and on several veinsin the vicinity of Atik Lake. Finds of silver ores have been reported from most of these from time to time, but no reliable data are to hand as to the extent of the ore found.

I am largely indebted to Mr. T. A. Keefer and others, who have collected and transmitted, from time to time, the foregoing information regarding the progress in the development of the Thunder Bay silver mines.

OTTAWA, June 1st, 1889.



A. P. LOW PHOTO. THE DOMINION ILLUSTRATED PRINT, MONTREAL

Group of Esquimaux, from East Coast of Hudson Bay; taken at Little Whale River H. B. Post

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON EXPLORATIONS IN

JAMES' BAY

AND

COUNTRY EAST OF HUDSON BAY,

DRAINED BY THE

BIG, GREAT WHALE AND CLEARWATER RIVERS.

BY

A. P. LOW, B.Ap.Sc.

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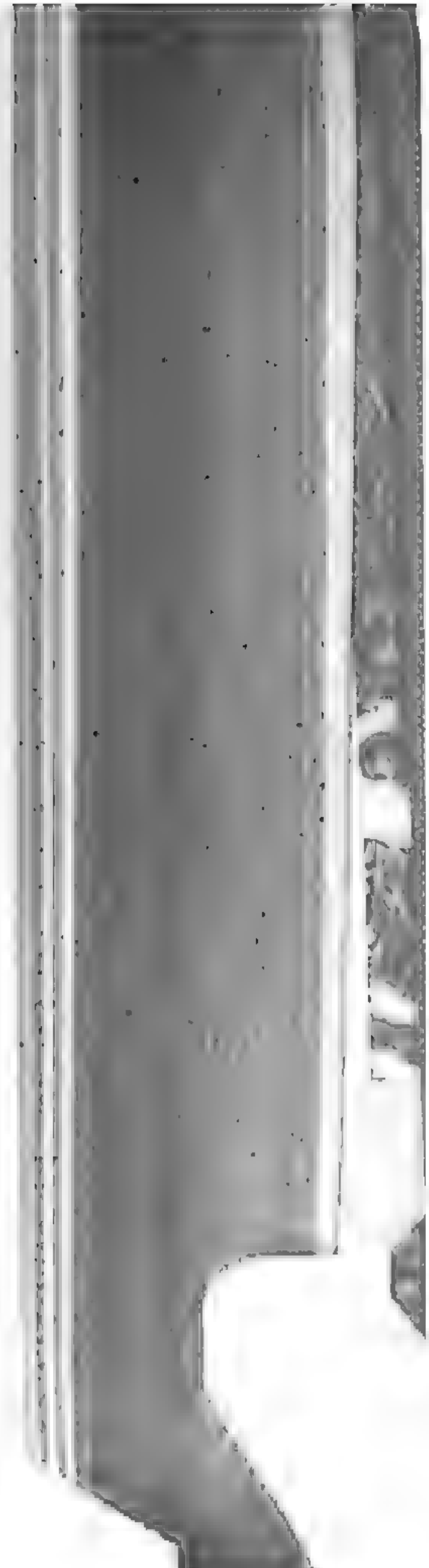


To Alfred R. C. Selwyn, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

Sir,—I beg to submit herewith my report on the explorations about Hudson Bay during the seasons of 1887 and 1888.

At the same time I desire to tender my thanks to the officers of the Hudson Bay Company, met during the two seasons, all of whom extended to myself and party the greatest hospitality, and to whose kindly assistance the success of my explorations was, in a great measure, due.

I remain, Sir,

Your obedient servant,

A. P. LOW.

REPORT

ON EXPLORATIONS IN

JAMES' BAY,

AND

COUNTRY EAST OF HUDSON BAY,

DRAINED BY THE

BIG, GREAT WHALE AND CLEARWATER RIVERS.

1887 AND 1888.

BY A. P. LOW, B. Ap. Sc.

The present report is the result of two short season's work, among the islands of James Bay in 1887, and upon the Big, Great Whale, and Clearwater rivers flowing into Hudson Bay on its east side in 1888. Owing to the shortness of the season suitable for investigation in these parts, and to the length of time required to reach and return from the field of work, only six weeks were spent in actual exploration each year, and consequently only a small area of this vast region could be explored.

Mr. J. M. Macoun acted as assistant and botanical collector, and performed his duties in all respects satisfactorily.

In 1887, a large fishing boat was procured at Collingwood, transported by rail to Missinaibie station on the Canada Pacific Railway and from there taken by the Missinaibie branch down the Moose River to its mouth. The low state of the water in the river, and the number of portages over which the boat had to be hauled occasioned considerable delay in reaching Moose Factory. Leaving Moose River, the party crossed to Charleton Island, the position of which has been fixed for longitude with chronometers by the captains of the Hudson Bay Company's ships, who have wintered there in past years. Subsequently Danby, Cary, Stratton, Little Charleton, Tiders, Solomon's Temple, Weston, Twins, Spencer, Walter, Emily, Grey Goose, Bear and Agoomski Islands were examined. Paced surveys were made around the shores of the greater number of these, as well as numerous examin-

ations inland, and their positions were fixed by latitude observations and meridional bearings taken with solar attachment to the transit instrument.

In 1888, a track survey was made up the Big River for two hundred miles, thence crossing the head-waters of Bishop Roggan River, the head of the south branch of Great Whale River was reached and the river descended to its mouth. On this survey the courses were taken with a prismatic compass, and the distances estimated by time, the rate of travel of the canoe being previously determined. Daily observations for latitude were taken as a check on the survey, also frequent observations to determine the variation of the compass.

After finishing the above, a survey was made from the mouth of Clearwater River on Richmond Gulf, for sixty miles, to the outlet of Clearwater Lake, the courses were taken with a prismatic compass and the distance with a Rochon micrometer, frequent observations for latitude and variation of the compass were also made.

Mr. C. H. Macnutt, B. Ap. Sc., who had been with me the previous year was appointed assistant, and proved highly competent for the position.

The surveys of the two seasons have since been mapped on a scale of eight miles to one inch, and form a roughly accurate map of the regions explored; they are at present awaiting further explorations on the east side of Hudson Bay before being published.

Previous Explorations and Discoveries.

It is deemed advisable to preface this report by the following short account of the discoveries, explorations, and other points of historical interest in connection with Hudson Bay up to the present date.

Hudson's Voyage, 1610.

1610.—Henry Hudson, in command of a ship fitted out by some wealthy English merchants, on his third unsuccessful attempt to find a north-west passage to the South Sea, had the good fortune to sail through the strait and enter the bay which has ever since borne his name. Sailing along the east coast to the southward until he had land on either side of him, he explored the bottom of the bay and as the season was now late, resolved to winter in a bay full of islands on the east side to the south of lat. 53° N. After passing a winter of great hardship, due to the cold, scurvy, and want of food, in the spring he started to return, when his crew mutinied, put Hudson, his son and seven seamen into an open boat and left them to the mercy of the waves and savages; nothing after was heard of the party, the ship with great difficulty reached the coast of Ireland with about one-half of the remainder of the crew, the rest having perished in a fight with natives in the straits and quarrels aboard the ship.

1611.—Sir Thomas Button was sent out to discover the north-west passage from the bay, and if possible to succour Hudson and his comrades. He crossed the bay to the northward and explored the western part as far south as the Nelson River, which he named after his mate. He wintered in the mouth of this river and called the land New Wales and the western part of the bay Button's Bay. Sir Thomas Button, 1611.

1619.—Jens Munk, a Dane, entered Hudson Bay and visited Thornfield Islet. Jens Munk, 1619.

1631.—* Capts. Lucas Fox and Thomas James were sent out on the old quest of the north-west passage, the former being fitted out by London merchants, the latter by those of Bristol. Before leaving they were presented to the King, who gave them letters for the Emperor of Japan. Fox confined himself to the northern parts, going as far south only as Cape Henrietta Maria, and then returning home. James, after meeting Fox, near Cape Henrietta Maria, sailed southward along the west coast, thoroughly examined it, and after several narrow escapes from shipwreck through grounding on shoals, ran his ship aground on Charleton Island and wintered there. He gives a woeful tale of the hardships endured, caused by the intense cold, want of food and scurvy. He states that the cold was so intense that it froze solid, wine, sack, oil, vinegar, and even brandy; that the cook soaked his salt meat in a copper kettle close to the fire to prevent it from freezing, the side near the fire was found to be quite warm while the opposite side was frozen an inch thick, this would prove that the climate is either much milder at present during the winter, or that James was given to exaggeration, most probably the latter. Thinking that the ship was beyond repair, in the spring he built a pinnace, but when the ice cleared it was found that the ship had not suffered much damage, after repairing it he returned home. Fox and James, 1631. Intense cold.

The entire western coast having now been explored, the impossibility of a north-west passage from it was settled, and no further voyages of discovery in that direction were undertaken.

1656.—The French† claim that Jean Bourdon was the first of that nationality who visited Hudson Bay, having sailed from Quebec by the Labrador coast and Hudson straits. That he made an alliance with the natives, and they hearing of a strange nation in their neighborhood, sent to Quebec, in 1661, to begin trade, and to desire that a missionary be sent to them. That in 1663 the Governor sent one Couture, who proceeded to the bay and erected a cross on an eminence and set up the French arms engraven in copper, taking possession of these countries for the 1656—First visit of the French.

* Forster's voyages made in the north.

† De la Poterie, Histoire de la Nouvelle France.

King of France.* This account has since been disproved, and it would appear that Jean Bourdon never entered Hudson Bay.†

DeGroisselier and Radisson reach Hudson Bay from Lake Winnipeg.

The next expedition sent to Hudson Bay was for purposes of trade with the natives. According to Oldmixon ‡ two Frenchmen, Messrs. de Groisselier and Radisson, while trading with the Indians at Lake Assimponals (Winnipeg) learned from them that it was possible to proceed by land to the bottom of the bay where the English had not visited. They desired the savages to conduct them thither which they did, they then returned to Quebec where they tried to persuade some merchants to send a ship under their command to the bay to engage in trade with the Indians; being unsuccessful they proceeded to Paris, hoping for a more favorable hearing at Court, but after presenting several memorials and spending a great deal of money and time, they were answered as they had been at Quebec. The English Ambassador hearing their proposals, imagined he should do his country good service in engaging them to serve the English who had already pretences to the bay, so he persuaded them to go to London where they met with a favorable reception from Prince Rupert and seven other wealthy men and merchants who, in 1668, fitted out the Nonsuch Ketch under command of Zachariah Gillam, a New England Captain. Accompanied by De Groisselier and Radisson, he passed through the straits and thence southward to lat. 51° N., where in the Nemiscow River, afterwards called the Rupert, he held friendly intercourse with the natives, built a rough fort called Charles Fort, wintered there and returned safely the following year.

Building of Fort Charles on the Rupert.

Charter to Hudson Bay Company, 1670.

Upon the return of Gillam in 1669, Prince Rupert and others applied for a charter to King Charles II. This was granted 2nd May, 1670, in it they are styled the Governor and Company of Adventurers trading from England to Hudson Bay; § "and in consideration of their having at their own cost and charges," undertaken an expedition to Hudson Bay in the north-east parts of America, for the discovery of a new passage to the South Sea, and for the finding of some trade for furs, minerals and other considerable commodites, and of their having already made by such their undertakings such discoveries as did encourage them to proceed farther in pursuance of the said design, by means whereof there might probably arise great advantage to the King and his Kingdom, absolutely ceded and gave up to the said undertakers the whole trade and commerce of all those creeks, seas, straits, bays, rivers, lakes and sounds, in what latitude soever they might be, which are situated within the entrance of the Hudson Straits, together with

* Joseph Robson's Hudson Bay, 1752.
† Chas. Bell's Hudson Bay.
‡ Oldmixon's British Empire in America, 1741.
§ Forster's Voyages.

all the countries, lands and territories upon the coasts and confines of the said seas, etc., so that they alone should have the right of trading thither, and whoever should infringe this right, and be found selling or buying within the said boundaries, should be arrested and all his or their merchandizes should become forfeit and confiscated, so that one-half thereof should belong to the King and the other half to the Hudson Bay Company."

Governor Bayly, 1670.

1670.—The Company sent out Chas. Bayly, as Governor, to establish a post at Rupert's River in 51° 20' N. Lat. He was accompanied by Groisselier and Radisson and remained in the country.

1673.—Groisselier visited the Nelson, but failing to find any Indians did not remain.

1674.—It being decided that a greater trade could be done with the Indians on the west side of the bay, owing to their remoteness from the French, Mr. Bayly made a voyage in a sloop to that coast, examining the mouths of the Moose and Schatawan or Albany rivers, and passing between the island of Agoomski (called by him Diner's Island) and the mainland, reached Cape Henrietta Maria, entering the mouth of the Equan River on the way. It had been his intention to proceed as far as Port Nelson, but having trouble with his guide he returned from Cape Henrietta Maria. During the same summer he sent a party to explore the Nodway or Frenchmen's River, but they only ascended as far as the first fall, a short distance from the mouth.

Arrival of missionary from Quebec by Lake Mistassini.

In the fall there arrived at Fort Charles a Jesuit missionary with letters from the Governor of Quebec; this was Père Charles Albanel, who reached the bay by ascending the Saguenay River to Lake St. John, thence up the Ashouapmouchouan River, across the Height of Land to Mistassini and down the Rupert River, which flows out of that lake. An account of his trip is given in the Relations of the Jesuits.* As he left Canada in 1672, he had been two years making the trip, having been detained by the Indians, who stripped him of his clothes, so that he had to be clothed by Mr. Bayly, who received him kindly and sent him home in the ship.

Establishment of posts at Hayes Island and Albany, 1675.

1675.—Outposts were established at Hayes Island, in the mouth of the Moose River, and at Albany. A short time after this the head fort was removed to Albany, and a depot established on Charleton Island, where the ship from England discharged her cargo, furs being brought there from the posts, and the next season's outfits returned in sloops.

1682.—Three parties reached the mouth of the Nelson River within a short time of each other; the first to arrive was Benjamin Gillan, a son of Capt. Z. Gillan, who had been sent from Boston; fourteen days later came Groisselier and Radisson from Quebec; they having been

* Rélations des Jésuits dans la Nouvelle France, vol. III.

discharged from the Company's service, returned to France, were pardoned, and sent out to take possession of the Nelson for the French king; shortly after these John Bridgar arrived to build a fort for the Company. All three parties landed, and lived at peace until spring, when Groisselier surprised Gillan and Bridgar, took them prisoners, and afterwards conveyed them to Quebec, in the meanwhile sending the other English in a rotten ship to meet the Company's ship, which they did near Cape Henrietta Maria.

1684.—Quarreling with their employers on their return to Quebec, Radisson and Groisselier again deserted to the English, returned to Port Nelson, and gave it up to the Company.

Mica mine on East Maine River.

1685.—In this year the Company had forts at Albany, Hayes Island, Rupert, Nelson and Severn; also a small post at a river on the East Main called "Ison-glass" River, where a mine of that mineral had been found, the working of which proved unprofitable.

1686.—The French in Canada, afraid of losing their inland trade with the Indians, and knowing that James II would allow no affront in this quarter to cause a break between him and Louis IV, resolved, in a time of peace between the two countries, to take possession of the English forts. The Governor accordingly sent a detachment of soldiers, under the command of Chevalier de Troyes, overland from Quebec, who easily took possession of the Forts Rupert, Hayes and Albany, leaving Port Nelson only to the English.

Capture of the forts by the French.

1690.—D'Iberville sailed from Quebec with two ships to capture Fort Nelson. He failed to do so, but obliged the English to abandon Severn.

1691.—Mr. Geyer, governor at Nelson, sent Henry Kelsey inland to make discoveries and extend the trade by inducing the inland Indians to come to the fort. According to his journal, produced by the Company before the Committee of the House of Commons in 1749,* "he set out from Deering's Point (probably Split Lake), where the Indians always assemble when they go down to trade, to seek the Stone Indians, and, after overtaking them, travelled with them and the Nayhaythaway Indians to the country of the Naywatamee-Poets, and was fifty-nine days on his journey, including the resting days. He first went by water seventy-one miles from Deering's Point, and then laid up his canoe and went by land 316 miles through a woody country, and then forty-six miles through a plain, open country, having seen only one river in his journey, shallow, but a hundred yards over; and after crossing ponds, woods and champagne lands for eighty-one miles more, which abounded with buffaloes and beavers, he returned back fifty-four miles, where he met the Naywatamee-Poets." From this it

Kelsey journeys from Fort Nelson to the Saskatchewan.

* Robson's Hudson Bay.

would appear that he travelled from some point on the Nelson River above Split Lake to the open country north of the Saskatchewan.

1693.—War having broken out between England and France, the Company, with the assistance of the Crown, retook Albany, Moose and Rupert forts.

1694.—D'Iberville, with two ships and 120 men, took York fort from the English, and the same year the French sent such a force from Canada that they easily drove the English out of Albany, Moose and Rupert forts.

Iberville captures Forts York, Albany, Moose and Rupert.

1695.—The Company, with the assistance of the Bonaventure and Seaford, a second time recovered Moose, Albany and Rupert forts.

1696.—The English, with four ships, took York from the French, carrying the garrison prisoners to England.

1697.—The French sent a squadron of five ships under D'Iberville, who destroyed two English ships, and afterwards took possession of York and called it Fort Bourbon. By the treaty of Ryswick, signed in this year, each country was to return all places taken during the war, holding those taken previous to it. By this the only place left to the Hudson's Bay Company was the fort at Albany. This state of things continued until the treaty of Utrecht, 1713, when the French ceded all their rights in the bay to the English.

1702.—The French rebuilt Fort Severn, calling it Fort Neuve Savanne, and the river Rivière des Saintes Huiles; they also called Moose Fort St. Louis, and Albany, Fort Ste. Anne.

1714.—The English formally took possession of York and the other forts on the bay.

Forts re-taken by the English.

1718.—A wooden fort was built at the mouth of the Churchill River, and named Fort Prince of Wales.

1719.—Capt. Knight sailed with two ships to search for a north-west passage from the northern parts of the bay. They never returned.

1720.—About this year the Company sent Richard Norton inland from Churchill, and, according to the testimony of Brown before the Committee in 1749, he is said to have reached the Coppermine River, but this is doubtful, as no journal of the journey was produced.

1732.—A wooden fort was erected at Moose, and a small post established at the mouth of the Slude, or East Main River. About this time a post was also built at Richmond Gulf for trade with the Northern Indians or Esquimaux. The people here on two occasions were massacred by the Esquimaux, and the post was then abandoned.

1737.—Two sloops were sent to the northward from Churchill to open trade with the natives, and look for a northern passage to the westward; this latter object seems to have never been seriously undertaken.

1740.—Henley House was built about one hundred and fifty miles up the Albany River, to prevent the Indians communicating with the French.

1741.—Christopher Middleton, sent out to discover a north-west passage, wintered at Churchill on account of a dispute between him and Mr. Dobbs; another expedition under Wm. Moor and Francis Smith were sent out to settle the matter. They wintered in the Hayes River, and an account of the expedition was written by Henry Ellis, who accompanied them.

Ellis' voyage.

1752.—Joseph Robson published an account of his six years' residence at York and Churchill, where he had been sent by the Company to oversee the construction of the stone fort at Churchill, and survey the mouths of the Hayes, Nelson, and Churchill Rivers, plans of which are published in his book. He complains of the lack of interest exhibited by the Company in regard to the interior, and says that the officers in charge had never been five miles up any of these rivers.

Capt. Coate's notes of voyages.

1727–51.—Capt. W. Coates for these years was Captain of one of the Company's ships voyaging to the Bay; during this time he kept a series of sailing notes, entering in them a full account of the geography of the Bay; these notes he bequeathed to his son, with instructions to him, not to reveal them so long as the Hudson Bay Company continued to employ him. These notes, edited by John Barrow, were published by the Hakluyt Society in 1857, and form an important source of information in relation to the coasts, rivers and islands of the Bay.

From the time of the treaty of Utrecht until after the conquest of Canada, the Hudson Bay Company confined their trade strictly to the Bay, and did not go inland until they found themselves in danger of losing their trade to the Canadian traders, who secured the fur by meeting the Indians on the headwaters of the rivers, and thus saved them the long journey to the sea.

Hearne's journey from Churchill.

The Company becoming aware of this fact, resolved also to send inland, and in 1769 despatched Samuel Hearne, from Churchill, with instructions to accompany the Indians to their hunting grounds, visit the copper mine on the river of that name, and if possible reach the sea at its mouth. After two unsuccessful attempts, he accompanied some Northern Indians and wandering over the barren lands with them reached the mouth of the Copper Mine River, then visited Great Slave Lake, and returned across country to Churchill in 1773.

On his arrival he was immediately sent inland again, to build Cumberland House, on Pine Island Lake, a short distance north of the Saskatchewan River, the first of the Company's many posts in the North-West. From this date the Hudson Bay Company entered into active competition with the Canadian traders for the inland trade, and

soon had a great number of posts scattered over the North-West and on the Mackenzie River.

David Thompson, at first employed by the Hudson Bay Company, and afterward by the North-West Company, was the first person to fix with any degree of accuracy the positions of the different posts, and make surveys through the country; he was engaged at this work from 1790 until 1812. From 1816 to 1826 he was employed on a boundary survey between Canada and the United States, from the St. Lawrence to the Lake of the Woods. Surveys by David Thompson, 1790-1812.

Philip Turner was another Surveyor, who explored extensively under the orders of the Hudson Bay Company, about the beginning of the present century, and may have made the surveys in Severn River country, as laid down on Arrowsmith's Map prepared for the Company.

In 1782, the French Admiral La Perouse entered the Bay with three war ships, and took Fort Prince of Wales, spiked the guns, and destroyed the factory, without any resistance being offered by Hearne, who was then in charge of the place; then sailing to York he destroyed a small battery at the mouth of the Hayes River, and burnt the factory, but failed to capture the Company's ships with their rich cargoes of fur. Capture of Churchill by Admiral Perouse.

1814.—Lieut. Edward Chappell, on H.M.S. Rosamond, the convoy to the Company's ships, visited Churchill and York. He published an account of the voyage, with descriptions of the Bay, and a map of the Nelson, from its mouth to Lake Winnipeg. Voyage of Lieut. Chappell

1820.—Sir John Franklin, on his first expedition overland to the Arctic Ocean, went by way of York and the Hayes River route to the Saskatchewan; he made a track survey of the route and published an account of it, in the narrative of the journey. Since that time many other travellers have passed over the same route. Franklin's journey.

Geographical explorations of the country to the eastward of the Bay were not undertaken until about 1820, when Dr. Mendry and Mr. J. Coulson made explorations, under orders from the Company, and have left rough maps of their work. The former traversed the country from Richmond Gulf to Ungava Bay; the latter explored the East Main, Rupert and Notaway rivers, also the portage routes between the head waters of these rivers.

Shortly after this posts were built at the mouths of the Little Whale and Great Whale rivers, where important porpoise fisheries were formerly carried on, but of late years have been abandoned as being unprofitable. Fort George, at the mouth of Big River, was also built about the same time, and is at present the headquarters of the East Main district. It has been found impossible to get the exact date at which these posts were established. Establishment of posts on East Main coast.

Missionary work

About 1847 the first missionary work among the Indians of Hudson Bay was undertaken by the Methodists. These withdrawing six years later, were succeeded by the English Church Mission Society, which has continued the work ever since, and at present has churches at Churchill, York, Albany, Moose, Rupert House and Fort George. Rev. Mr. Peck, in charge of the last place, visits Little Whale River every spring, to meet the Esquimaux who come in from the islands at that time. By the efforts of these missionaries the whole of the Indians and the greater part of the Esquimaux living around Hudson Bay have become Christianized, and their moral tone considerably elevated.

Previous explorations by the Geol. Survey staff.

The Roman Catholics have a number of converts at Albany, who are yearly visited by a missionary of that faith from the Upper Ottawa.

The explorations in this section of the country undertaken by the Geological and Natural History Survey of Canada, previous to the present, are:—

Report 1871–2. Upper part of the Albany River. Dr. R. Bell.
Report 1875–6. Mattagami and Missinaibie branches of the Moose River. Dr. R. Bell.
Report 1877–8. East coast of Hudson Bay, and country between Lake Winnipeg and Hudson Bay. Dr. R. Bell.
Report 1878–9. Churchill and Nelson Rivers. Dr. R. Bell.
Report 1879–80. Hudson Bay and some of the lakes and rivers lying to the west of it. Dr. R. Bell.
Report 1880–1–2. Geology of the basin of the Moose River. Dr. R. Bell.
Annual Report 1885. Observations on the Geology, Zoology and Botany of Hudson Bay and Strait. Dr. R. Bell. Report on the Mistassini expedition. A. P. Low.
Annual Report 1886. Attawapishkat and Albany Rivers. Dr. R. Bell. Severn and Berens Rivers. A. P. Low.

James Bay.

James' Bay.

James Bay is that portion of Hudson Bay lying south of a line drawn from Cape Henrietta Maria, on the west, to Cape Jones, on the east coast. From the head of Hannah Bay, N. lat. 50° 55′, to Cape Henrietta Maria, the distance is, roughly, 300 miles, while the average breadth is 145 miles.

Incorrect maps

From Cape Henrietta Maria the coast runs S.S.E. to Mourning Point, a low point covered with trees, near lat. 54° 38,* then south to Equan Point, lat. 53° 53′; from there it trends well to the westward, to the mouth of the Equan River, and then east of south to the mouth of the Albany River, lat. 52° 17′, thus forming a considerable bay, and not running almost due north and south as represented on all modern maps.

* Capt. Coats' Notes.

From the mouth of the Albany River the direction of the shore line changes to E.S.E. for a distance of forty miles to Cockespenny when it turns S.E. to the head of Hannah Bay. Hannah Bay is thirty miles deep, counting from a line drawn between Gull Point on the east side and the mouth of Moose River, and has an average breadth of fifteen miles.

This bay is separated from Rupert Bay by a long low point terminating in a peninsula, at one time an island, the isthmus is covered with willows and is lower than the land adjoining, the latter, on both sides, supports a thick growth of spruce and tamarac. Rupert Bay is thirty-five miles deep, with an average width of twelve miles.

The east coast of James Bay has a roughly north and south direction from the head of Rupert Bay to the mouth of Big River, one hundred and seventy-five miles. From this river the coast takes a gradual curve to the westward, the land at Cape Jones lying about east and west.

According to Capts. Taylor and Bishop, of the Hudson Bay Company's ships, the position of Cape Jones, as laid down on the Admiralty chart, is fully forty miles to the eastward of its true position; this being the case, the mouth of James Bay is that much narrower than is represented on the maps.

The Admiralty chart, from which all modern maps of Hudson Bay are constructed, was compiled in 1853 from information supplied by the Hudson Bay Company, gathered from notes and observations of the various captains of their ships; now as these observations were but approximately correct, the chart must be so also, especially in those parts unfrequented in the navigation of the bay, and such being the case, it is highly important that an accurate survey should be undertaken to correct these errors in the coast line, and enable ship captains unacquainted with the navigation of these parts, to enter James Bay with a certain degree of safety, a thing impossible with the present charts.

Importance of an accurate survey being made.

The general coast line of the west and south sides of James Bay is low and flat, with shallow water, deepening very slowly outwards all along, except where the rivers have cut out channels in the mud.

Tides.

Although the average rise and fall of the tide does not exceed five feet, at the time of low water, only mud flats, strewn with large boulders, can be seen to seaward from high water mark. The shore is, in most places, marshy, covered with grasses and willows, with numberless small brackish ponds and lakes for a considerable distance behind high-water mark, while beyond, on slightly higher ground, is a dense growth of dwarfed black spruce and tamarac; it is often several miles from low-water mark to where the first really dry ground may be found.

Shoals and mud flats.

Hannah Bay is so shallow that, with the exception of the river channels, it is almost completely dry at low water, and when a canoe is left by the tide, the sensation experienced by its crew is anything but pleasant, as they have to debark and stand in the mud, often beyond sight of the low fringe of bushes on the high water line, awaiting the return of the water. Rupert Bay is not quite so shallow as Hannah Bay, and has a channel up its centre to the mouth of the Notaway River.

Character of the coast on east side of the bay.

Along the east side of the bay the character of the coast changes, the low unbroken, muddy shores being replaced by higher rocky and sandy banks, deeply indented with small bays and fringed with innumerable rocky, shingle and sand islands as described by Dr. Bell (Report of Progress 1877-8.) The waters are much deeper and, although not free from danger on account of many hidden shoals, can be easily navigated in small craft, the islands and bays affording abundance of good shelter. The country inland from the bay varies similarly to the coast line. To the west and south it is almost flat, with its soil overlying nearly horizontal beds of Silurian and Devonian limestones for about one hundred and fifty miles inland to the Archæan country, so that the general level rises slowly and evenly towards the interior. The soil along the rivers appears to be good, and as the climate to the southward is probably favorable for the growth of cereals and root crops, nothing prevents future settlement in this region after the filling up of the north-west, except that without an extensive system of drainage, the lands remote from the rivers will be found too wet for successful farming, as it is said by the Indians, that with the exception of lands close to the rivers, the greater part of the country for a long distance inland from the bay is a mossy swamp.

Silurian and Devonian limestones.

Good soil.

Inland from the east coast the country is of a different character. The interior of this part is a rough table-land having an elevation of about seven hundred feet above sea level near its edge, and slowly rising inland to over two thousand feet at its highest.

Character and elevation of the interior table-land.

The edge of this table land leaves the coast to the north of Cape Jones, and runs in a S.S.E. direction, so that to the southward there is an interval varying from ten to thirty miles between it and the coast. In this portion the general level is not much over one hundred feet above the sea, and the soil is of Post-Pliocene clays and sands, with alluvium, affording good land for cultivation but as the climate is colder than on the west side, it is doubtful if it would allow the successful growth of any but the hardiest cereals, good crops of potatoes, however, and other roots could be and are grown as far north as the mouth of Big River. The land is rolling and broken by low rocky

Archæan hills which make up about one-third of the entire area, all of which would make excellent grass land. The best portion of it is along the river bottoms, and on the islands and banks. Root crops. Good grazing land.

Eleven large and many smaller rivers flow into James' Bay; on the west side are the Equan, Attawapishcat, Albany, and Moose rivers; on the south, Hannah Bay or Harracanaw, and the Nottaway rivers; on the east, the Rupert, East Main, Old Factory, Big and Bishop Roggan rivers. Rivers.

The water-shed of the country on the west side runs in a south-west direction from Cape Henrietta Maria, and consequently the rivers to the southward, having greater drainage areas, are the largest and longest.

The first river to the south of Cape Henrietta Maria is Raft River, an inconsiderable stream, the outlet of Raft Lake; it reaches the sea in lat. 54° 04′.

The next river is the Equan, a much larger stream, which takes its rise 300 miles to the westward, at the watershed between it and the Winesk River, flowing north; it enters the bay at lat. 53° 38′.

About lat. 53° 24′ are the two mouths of the Attawapishcat River, which rises over four hundred miles inland, near the source of the east branch of the Severn River. It flows north, and drains an extensive area of unexplored country between the Equan and Albany rivers.

The Kapiscow River is a smaller stream entering the Bay at lat. 53° 05′.

The next important stream to the southward is the Albany River, the longest and largest on the west side of James Bay.

This river, one hundred and forty miles in a straight line south-west from its mouth, divides into two branches. The north or main branch comes from the west; it takes its rise a short distance from the head-waters of the English River, in Cat or Cat-fish Lake, about one hundred miles north-west of Lake St. Joseph, through which it flows, and which flows into Lake Winnipeg. The south or Kenogami Branch flows from Long Lake, thirty miles from the north shore of Lake Superior. At its mouth the Albany spreads out and flows between a number of low, swampy islands, forming a delta twenty-three miles long and ten miles broad between the mouths of its channels, the most southward of which empties into the sea in lat. 52° 12′.

At the south-west angle of the Bay is the wide mouth of Moose River, whose branches drain all the country to the south-west and south, from the rivers flowing into the eastern portion of Lake Superior and the headwaters of the Ottawa. The western or Missinaibie branch flows out of Missinaibie Lake, at the head of the Michipicoten River, within fifty miles of Lake Superior; the middle or Metagami branch flows from the south, and drains the country north of the

watershed to Lake Huron; the eastern or Abitibbi branch flows out of Lake Abitibbi, a short distance from Lake Temiscamingue on the Ottawa River.

Varying character of the rivers.

All the rivers flowing into the west side of James' Bay present the same physical characters; on their headwaters and upper parts, while flowing over Archean rocks, they alternate between long lake-like expansions with little current, and short contracted portions accompanied by heavy rapids and falls, thus affording good stretches of navigable water with portages between. On their lower courses, for a distance of one hundred and fifty to two hundred miles from their mouths, where they pass over the flat Devonian and Silurian limestones, the fall is uniform, and consequently the character changes, so that in ordinary low water during the summer and early autumn, owing to this uniformity of fall and to the rivers having too great a breadth for the amount of water discharged at this period, they present an almost unbroken succession of small shallow rapids, full of boulder and gravel bars, and only navigable for canoes of light draft.

Navigation.

For three or four weeks after the ice leaves the rivers, during the spring freshet, and again after the autumn rains, the higher water flattens out these numerous rapids and covers all obstructions, so that navigation with large boats, and even small steamers, is then possible; but at these times the current has a uniform rate of between five and six miles an hour, and therefore comparatively powerful steamers would be required to ascend the streams, the boats at present used being tracked up by men along the banks.

Near the head of Rupert Bay the Little Nottaway River enters. It is a small stream draining the country to the south between Hannah Bay and Nottaway River. This was called formerly Onengham Creek and was used as a winter harbour by the first voyageurs to the bay in the Company's service.

The mouth of the Nottaway River is directly at the head of Rupert Bay. This is a large river, one of whose branches rises in Lake Chibougamoo, a short distance to the westward of Lake Mistassini, and to the northward of the headwaters of the Ashouapmouchouan River, which empties into the Saguenay by way of Lake St. John; the other branch comes from a more southerly direction and rises near the heads of the Gatineau and St. Maurice rivers. In its lower parts the Nottaway River is so rough and rapid that instead of using it as a route to Waswanippi, a post on its upper waters, the Hudson Bay Company's canoes ascend the Rupert River, itself a very bad route, for one hundred miles to Lake Nemiscow, and thence pass by a portage route through small lakes and streams to the Nottaway.

On the east side of Rupert Bay, about half way between the mouths of the Rupert and Nottaway rivers, a small stream called Fish River enters.

In lat. 51° 30′, on the east side of Rupert Bay and near its mouth, the Rupert River flows in. This large body of water flows from Lake Mistassini, which is fed by several comparatively large streams, the longest and largest of which is the Temiscamie River, which rises to the north-east of the lake, near the headwaters of the Peribonka River flowing into Lake St. John.

The Rupert River, for one hundred miles from the sea, is very rough, and in ascending it canoes with their loads are forced, on account of its heavy rapids and falls, to make portages aggregating over ten miles in length.

Portages on Rupert River route.

Continuing up the east side of James Bay, the next river flowing in is the East Main or Slude River, whose mouth is in lat. 52° 15′. This is a very large river, rising fully five hundred miles inland at the central water-shed of the Labrador Peninsula, which divides the waters running north into Ungava Bay, from those flowing west and south into Hudson Bay, and the Gulf of St. Lawrence respectively.

As has been previously stated, the course of the East Main River was roughly laid down by Mr. Clouston in 1824, who made a track survey to near its head. A copy of his map was obtained at Little Whale River last year and it is now in the office of the Geological Survey. The Hudson Bay Company use the upper part of this river as a route to their post of Nitchicoon, situated on a lake a short distance beyond the height of land on the head of one of the rivers flowing north into Ungava Bay. The route followed from Rupert House is by the Rupert River to a short distance beyond Lake Nemiscow, where a northern branch is taken, and passing thence through a chain of lakes, the East Main is reached, about two hundred miles from its mouth, and then ascended to its head through several more lakes. The lower part of the river is broken by a number of heavy rapids and falls, entailing long portages, and therefore the Rupert is taken in preference, thus obviating the long coast journey in open canoes, with its attendant delays and dangers. The present route to Nitchicoon is so difficult that the Hudson Bay Company have tried to find an easier one by the Big River to Fort George, but this was ascertained to be longer and harder than the one used at present. The difficulty of the trip can be appreciated when it is learned that the large canoes leave Nitchicoon with the first open water in the spring and are often dragged over the frozen lakes to the river, they thus reach Rupert House about 1st July; where, unloading their furs, they embark the trading outfit for the ensuing year and start immediately inland, only

Falls and rapids.

reaching Nitchicoon at the close of open water, and frequently they have been frozen in before reaching their destination, in which case the outfit has had to be hauled to the post on sleighs after the snow had fallen.

About lat. 52° 33′ the next large stream, called Old Factory or "Isonglass" River enters the bay. This is the river on which the company had a small post in 1685, and attempted to work a mica mine, but abandoned it as unprofitable. The only information obtainable concerning this stream is that it is a much smaller river than the East Main, and that its mouth is obstructed by sand and shingle shoals. To the northward of this are several small streams before the mouth of Big River is reached in lat. 53° 53′.

Mica mine.

Big River.

Big River is the largest river flowing into James Bay on the east side, and discharges probably a larger volume of water than the Albany, and therefore is the largest river entering the bay. In the latter part of this report it is more fully described.

Other rivers.

Between the Big River and Cape Jones are the mouths of several rivers of considerable size, the largest is the Bishop Roggan, the other important ones being the Little Bishop Roggan, Seal and Salmon rivers. These drain a large area of country between Big and Great Whale rivers.

General character.

The rivers entering James' Bay from the east for their entire length, pass, so far as known, through Archæan country, and consequently present physical characters somewhat different from those on the west side. On their headwaters they flow on the general level of the country and are nothing but a succession of lakes connected by short stretches of rapid rivers. After they have attained considerable volume and as they approach the margin of the interior table-land they begin to assume a true river character; they flow, with a moderate current, broken by sharp falls and heavy rapids, in old river valleys cut below the general level. Near the margin of the table-land the valleys become deeper, and the rivers are almost a constant succession of heavy rapids and falls until they reach the lower country, where they flow with a moderate current, with but few small rapids, in a distinct river valley between clay and sand banks of Post Pliocene age.

Harbours.

Settlement.

In relation to the future settlement of the country around James Bay and to the possibility of its use as a highway for future commerce between western Canada and Europe, the question of its harbours and their terminal facilities for railways is of the greatest importance. It is to be regretted that the natural harbours at the mouths of the

different rivers in the southern part of the bay meet the requirements of modern shipping only to a very moderate degree, and that to improve them sufficiently to admit of their being used as ports by large ocean steamers would entail an expenditure hardly likely to be warranted by the trade development of the future in this region.

Mouth of Moose River.

The most important harbour in this part of the bay is that at the mouth of Moose River. A description of it is given in Capt. Coats's notes on the geography o Hudson Bay, 1727-51, and as it has changed but little since then, his sailing directions may here be quoted: "From the Gaskitt fifty-eight miles S. by W. you come to Moose River Road, eight miles from Sand Heads, North Point W.N.W. six miles in lat. 51° 34', where you wait for the tide to go into that wide mouthed river which is not less than twelve miles over from North Point to the opposite side; which opens with three channels, but the north and east are so choked with banks and shoals, there is no using them; the mid channel will admit of a ship of twelve feet. Observing the tide over a bar one mile broad and one mile within Sand Heads is a little place which affords water for a ship to be afloat, called Little Ship Hole, to distinguish it from another four miles above Sand Heads, called Ship Hole, in three fathoms low water, where we moor and do our business. Eight miles below the factory on Roberson's Islands from Middleborough (Island) another island runs a shoal within half a mile of the ship, which cuts the river and prevents the ship going to the factory, which has plenty water all above that place."

From this it will be seen that a ship while awaiting the tide to cross the bar, has to lie six miles from the mouth of the river, in a very dangerous position with a north-east gale. The channel on the bar is not over four hundred yards wide, and the Hudson Bay Company's ship, drawing fourteen feet of water, last summer, ran aground while crossing it, and had to remain in that exposed place until the next high tide.

Railway terminus.

The eight miles from the Ship Hole to Moose Factory is in places very shoal, and is rapidly filling in its upper part, so that the Company's schooner, drawing eight feet of water, can only come within about two miles of the Factory, whereas a few years ago her cargo was discharged close alongside that place. If a railway should be built to this harbour its terminus will need to be at Ship Hole; and to reach it a long and expensive line of embankment will have to be built from the South Shore, across sand and mud flats, partly bare at low water, and, owing to its exposed position, it would need to be correspondingly strong to withstand the force of water during the late fall gales. If approached from the north side, a large bridge will be required to cross the channel to the "Ship Sands," a low, flat, muddy island, partly cov-

ered with water at high tide, and lying close to the Ship Hole; in either case the terminus will have to be built largely on made ground.

As the present anchorage, six miles without the bar, is in only thirty-six feet, and as the water gradually shoals toward the river's mouth to a depth of fourteen feet at high water on the bar, and is only eighteen feet at low water at the Ship Hole, with a less depth of water for the four miles between it and the bar, it will be seen that to fit this harbour for the entrance of moderate-sized steamers, with a draft up to twenty feet, extensive dredging operations will be necessary for almost the entire distance from the outer anchorage to Ship Hole.

Poor harbours.

Unsatisfactory as are the natural conditions of Moose Harbour, those at the Albany and Rupert rivers are worse. Off the mouth of the Albany, for fifteen or twenty miles, the bottom is very flat and the deepest water not over twenty-five feet, slowly shoaling to twelve feet at the mouth, with numerous obstructive shoals and bars, the whole rendering it impossible for deep draft vessels to use it. The country around the mouth of the river is so low and swampy that it is hard to say where the land ends and the sea begins, and is totally unfit for the purpose of a railway terminus. To reach the mouth of the Rupert a narrow channel in Rupert Bay must be followed, with water from thirty to twenty-five feet deep, after which it shoals to eighteen feet for seven miles to the junction of the Nottaway and Rupert River channels, and then eight miles of water varying from ten to fifteen feet, with dangerous shoals, must be passed to enter the river proper. From this it will be seen that this harbour can only be approached by small vessels of light draft, and can never be used by the large-sized steamers engaged in modern ocean transportation. The mouth of the East Main River is broad and consequently shoal, with not more than eight feet of water on the sand bars at its entrance; while for more than twelve miles from its mouth, on all sides, are innumerable boulder and sand shoals, and small rocky islands, some of which are partly bare, the whole rendering an approach to the river so highly difficult and dangerous that the Hudson Bay Company's schooner does not call there.

Big River harbour.

The mouth of Big River is the only good natural harbour on James Bay, and, with a small amount of dredging, would afford capital accommodation for large vessels. A ship entering the river has to pass a few low islands lying off its mouth, but as there is good water and plenty of sea room between them, they occasion little danger. Within four miles from the mouth of the river a good harbour is formed by two rocky islands lying close to the north or main channel; this is called Stromness Harbour, and, having a good anchorage, with plenty of water, well sheltered on all sides, is a convenient place to await a suitable state of tide to enter the river.

Good anchorage.

At the mouth of the river the channel is divided by a sandy shoal, partly bare at low water; the north channel is the deeper, and is used by the Company's schooner, chiefly owing to its proximity to Stromness Harbour, as there is a sufficient depth of water in either channel to float that craft. From Stromness Harbour the channel runs eastward directly towards the shore for two miles, when it turns sharply southward, one mile along the shore, to the mouth proper of the river, which can then be ascended about two miles to Fort George, where large vessels can be moored close to shore. From Stromness Harbour to Fort George at high tide the least water in the channel is eighteen feet. Fort George being situated on an island, there is another channel on its south side, but this is very small and obstructed by shoals, navigable only by small boats.

The island would afford excellent ground for a railway terminus but the difficulty of building a line along the east coast from the south end of James Bay, a distance of 180 miles, with the large bridges required to cross the Nottaway, Rupert, East Main and Old Factory rivers, would entail an expenditure hardly warranted by the amount of trade to be developed.

Fisheries of inland waters.

The development of Big River harbour will come with that of the immense and excellent fisheries of the inland lakes of this region and to the northward, as well as the coast fisheries, which, after the failure of the present sources of supply, will be of great importance and value.

From Big River to Cape Jones the bay is obstructed by many low islands and shoals for several miles from the coast, and as the bottom is uneven and the water not deep, large vessels cannot approach the mouths of the rivers flowing into this part. To the northward of Cape Jones the character of the coast soon changes, becoming higher and more rocky, with bold water close in shore. The mouth of Great Whale River would make an excellent harbour if a channel were cut through the sand-bar that at present obstructs its outlet, and over which the Company's schooner cannot pass at low tide.

Little Whale River is also obstructed at its mouth by a dangerous bar, which can only be crossed by small craft, and is impassable when the wind blows freshly from the north to west, at such times being covered with tremendous breakers.

Other harbours suitable for small craft occur at frequent intervals among the islands and bays along the whole eastern coast, but are all too small and shoal for large vessels, except one at Cape Hope Islands, about twenty miles north of East Main River.

Islands.

Three groups of islands.

The islands of James Bay, from their geographical position and physical character, may be conveniently divided into three groups. The first consists only of the large island of Agoomski, lying off the western shore; the second includes the high drift islands, situated to the eastward of a line drawn through the middle of the bay, and separated from Agoomski on the west by a deep water channel; the third is composed of the rocky islands and sandy shoals along shore on the east coast. The Island of Agoomski, or Omer's Island, as it was called by Governor Bayly in 1673, is the largest in James Bay, being seventy-five miles long, with an average breadth of ten miles.

Agoomski.

Its south end lies about thirty-five miles N. E. from the mouth of the Albany, and is consequently about twenty-five miles directly east from the coast.

The eastern shore of the island runs N. N. W. for thirty-five miles from its south end, and then bending more to the westward runs W.N.W. to its north end, which is in Equan Bay, and distant about eight miles from the main land, so that the position of the island is inaccurately laid down on the present published maps, which show it lying roughly parallel to the coast and about fifty miles distant from it. Indians coming from the northward to Albany on the ice, in the winter, when travelling in a straight line from Equan Point to the mouth of that river, cross the north end of Agoomski, showing that part to lie well in shore. The island closely resembles the adjoining main land in physical character, being very low and swampy. The shore line above high-water mark is made up of muddy flats covered in part with grasses and sedges, followed farther inland by thick growths of small willows, these in turn giving place to small black spruce and tamarac as slightly higher ground is reached. The line of these trees is often over two miles inland from high-water mark, itself a long distance from the sea at low water. As far as the tree line and in places beyond it, are numerous small lakes and ponds of brackish water; good fresh water being only obtainable in a few places well inland.

Vegetation.

The shore between high and low water mark is composed of a stiff slimy mud. Scattered over it are many boulders of gneiss, large and small. At the various points the boulders are often piled together, forming higher elevations than the surrounding flats.

The water around the island is very shoal for several miles out, and as the bottom is uneven, being broken by numerous boulder shoals and bars, it is very dangerous to approach even with small boats owing to the dirty state of the water. In fine weather the first

notice given of these shoals is the bumping of the boat upon them. On the west side, between the island and the main land, the water is shallower than on the east side, so that at low tide the distance between shore and shore is reduced in some places towards the north end to not more than one mile. This is taken advantage of by the Indians, several families of whom hunt on the island, crossing from the main land to the island in their small canoes. They start from shore at high tide and follow the retreating water out to its lowest point, cross the narrow channel and reach the high water line on the opposite shore with the rising water. From its close resemblance physically to the western mainland, it is probable that Agoomski is underlaid by the nearly horizontal beds of Devonian limestone found on the rivers near the coast. If this is the case, the rocks are covered with drift material on the lower half of its east side, which is the only part of the island that has yet been examined geologically.

The fresh and brackish lakes and ponds on the island are favorite breeding places for ducks and geese, which congregate here in countless numbers in the autumn to feed on the grasses growing along the low shores. The snow goose is reported to breed here when delayed on its passage north in the spring. Rabbits and cariboo are reported to be numerous, white bears frequent its shore, and the fur of the otters killed here is remarkably good and dark. Owing to the shoal character and muddy state of the water around the island, few fish are caught along its shore. Animals.

The principal islands composing the second group are Charleton, Danby, Cary, Woods, Little Charleton, Struttons, Weston, Solomon's Temples, Twins, Spencer, Walter and Grey Goose islands, along with the Bear Islands, lying more to the westward. These have a close resemblance to one another, both in formation and physical appearance, being composed wholly of sand, clay and boulders, with no bedded rocks in place. They all rise to considerable elevations above the sea level, present sharp escarpments, composed of clay and sand, along their margins, and the formation of all was probably due to the same causes, as shown later on in this report. Sand, clay and boulders.

Charleton, the second largest island in James Bay, lies about twenty miles north of Point Comfort, the end of the peninsula separating Rupert from Hannah Bay, and about one-third of the distance across the bay from the east coast, its north-east point being in lat. 52° 2′ 13″. In shape it is an oblique parallelogram, having diagonals eighteen miles long from north-east to south-west, and twelve miles long from north-west to south-east. As before stated, this island, like the others of the group, is composed of unstratified sand, clay and boulders, without any rock in place. Charleton Island.

The interior is a rough, rolling plateau, varying in elevation from 50 to 200 feet above sea level. On the south and east sides it ends in an abrupt escarpment, highest on the south; on the west and north the high interior land descends with an unbroken slope to a low shore. Starting from South-east Point, this escarpment runs westward at an angle of twenty degrees to the shore, consequently, on its west side it is a considerable distance inland. At the east end it has an elevation of seventy-five feet above sea level. This increases for four miles, where the maximum elevation of 200 feet is reached, fifty feet above the general level of the interior plateau, and standing above it with a cut bank that height on the north side, one-quarter of a mile from the southern margin of the escarpment, beyond which it decreases slowly westward, and is lost in the general low level of the west side. The face of the escarpment was examined at several points along its length, and found to consist of a moderately fine, light sand, with some clay, coarser gravel and small boulders mixed through the mass, the whole showing no signs of stratification. Going north from the south-east point for one mile, the escarpment averages sixty feet in elevation, with its base within a few yards of high water mark. Behind this, at a distance of 200 yards, is a second escarpment, thirty feet higher than the first. These, on their face, have the same composition as the southern escarpment. At the end of this course, and for one mile and a-half beyond to House Point, the descent from the interior is less precipitous, the land rising in three terraces—the first, ten feet, the next, forty feet, and the highest one, a quarter of a mile inland, 100 feet above the sea.

From House Point, for half a-mile, the face of the twenty-foot terrace is made up of sandy clay, with much gravel and boulders, rising out of deep water. From here the escarpment turns N. 30° W. for five miles, and then east five miles and a-half, passing inland around the head of a low, muddy bay, and reaching the shore again one mile south of the north-east point.

Terraces.

Here, on the east side, two distinct terraces are visible, the lower being fifteen and the higher seventy-five feet above the sea. The face of the inner terrace is chiefly sand, mixed with a considerable quantity of clay, and with many boulders scattered through the mass. To the westward of the north-east point, along the shore, the lower terrace is soon lost in the upper one, which, a mile beyond the point, shows a face of forty feet, composed of an unstratified sandy clay matrix, holding large quantities of boulders and coarse gravel.

Further to the westward the cut bank gradually loses its elevation, and two miles beyond the last described place is only about ten feet high; from here to the south-west point no banks occur, the shore line being

low, and formed of sand and mud, with many loose boulders scattered over it. At frequent points along this part of the shore the boulders are heaped up together, thus rising a few feet above and breaking the monotony of the general level of the shore.

Most of the boulders are of Laurentian and Huronian gneisses and schists, associated with light yellow fossiliferous limestones of Devonian and Silurian age, non-fossiliferous, light and dark limestones similar to those found at Lake Mistassini and along the coast to the north of Cape Jones, and also masses of the dark green traps found associated with the latter rocks. Character of boulders.

From the base of the escarpment on all sides, numbers of clear, cold springs of excellent water issue at all seasons. Following the shore from the south-west point, the course is due east for half a mile along a sandy beach, about fifteen feet above high water, covered with many boulders near the point; then turning N.N.E., a similar sandy shore covered with coarse grass and low willows is passed over for one mile and a-half to a flat muddy bay; this bay, with another on the west side, leaves at high tide only a low narrow neck joining the south-west portion of the main island. From this bay the course of the shore changes to S. 70 E., and runs in this direction seven miles to South-east Point. Between the escarpment on the south side of the island and the shore is a considerable area of low swampy land not rising over ten feet above high water mark, where a low embankment averaging twenty feet broad, composed chiefly of boulders bedded in clay, has been pushed up by the floating ice, and forms a natural dyke to the lower land behind, which is very swampy and partly covered with long narrow fresh water lakes lying parallel to the escarpment and shore. Between high and low tide on this side, is a wide mud flat strewn all over with a great number of boulders. Beyond low tide mark the water is very shoal for a long distance out; with the exception of the stretch of coast on the east side, from South-east to half a mile beyond House Point, the above description of the shore applies to the whole of Charleton Island. To the westward and northward sand and boulder shoals, bare at low water, extend out for miles from the island, rendering it impossible for ships to approach from those directions. Good water.

The bay on the east side with the escarpment passing around it, already mentioned, is two miles and a half wide and one mile deep; at low water it is completely dry and exposes a broad mud flat, with many large boulders upon it.

The land between the water and the escarpment, like that on the south side, is very low and swampy, with over one-half its area covered by small shallow lakes, formed or enlarged by numerous beaver dams, upon the three small streams that flow into this bay.

Danby and Cary Islands

To the eastward of Charleton lie two small islands; the southern, called Danby, being two-thirds of a mile distant; the northern or Cary, two miles from Charleton.

Between these islands and Charleton is a deep channel, through which the tide runs, with a current varying from three to five miles an hour. At House Point the water is deep close along the shore, and it was here that Captain James wintered his ship in 1631; here, also, in 1675 the Hudson Bay Company's ships discharged their cargoes from England, and took in the furs brought from the different forts on the Bay in sloops. In 1695 this depot was abandoned, and the anchorage has since been used only by the Company's ships when obliged to winter in the Bay, as it is the only moderately safe place in the southern part of James Bay where a ship may winter and allow the crew to obtain good water and fuel. The last ship wintered here in 1884; remains of the low huts, partly built in the ground for the officers and crew, are to be seen about one-quarter of a mile south of House Point on the first plateau island, near a fine large spring of clear water, which never dries or freezes, and is consequently available throughout the year. On the point is the frame of a large shed, formerly covered with sails, in which the ship's cargo was stored. The only drawback to this place as a wintering ground is that the strong current setting up and down the channel causes it to open early in the spring, and it then carries large masses of ice forward and backward, which striking the ship are a source of great damage and danger.

Wintering place for ships

Trees.

The soil of the high interior land being light and sandy, the rain readily soaks in, and consequently no lakes or streams are found on the surface, which is partly covered with moss. The trees growing in the interior are chiefly small white and black spruce, with a few aspen and balsam poplar, growing much thicker to the northward than on the southern parts, where they form open glades, the intervening spaces supporting a growth of small birch (*Betula pumila*) from one to two feet high. About one-half of the south-eastern portion of the plateau has been burnt over, leaving nothing but the bare sandy plain with small patches of moss growing on it, and presenting a very barren appearance. Between the escarpment and the shore, also on the low swampy lands on the west side, the trees are almost wholly made up of black spruce, with a few tamarac and balsam poplar. Fringing the shore are extensive areas of low willows, beyond which grasses and sedges alone grow over these portions at or near high water mark, where the shore is frequently overflowed by the tide. Cariboo and black bears in small numbers are found on the island; white bears often land after heavy gales on its northern shores; rabbits are very plentiful, but the island is chiefly noted for the beavers that abound in all its

Rabbits and other animals.

small lakes, being preserved by the Hudson Bay Company, who claim to have introduced them, and only allow them to be hunted every third or fourth year. The small lakes are favourite breeding places for ducks and grey geese, which find good feeding grounds on the low grassy flats along the shore, ptarmigan also breed on this island, it being their southward limit around Hudson Bay.

Danby Island, as before mentioned, is distant two-thirds of a mile from the southern portion of the east side of Charleton Island. It is roughly triangular in shape, each side having a length of two miles; one side lies parallel to Charleton, with its middle directly opposite House Point. Its shores are low and made up chiefly of sand and boulders, with muddy stretches between the points, and a raised bar of sand and boulders formed by ice, similar to that on the south side of Charleton, runs around the island near high water mark. Shoal water extends out from the north, east and south sides for long distances. The interior of the island is low and swampy, covered with a thick growth of small black spruce and tamarac, with a few balsam poplar.

Cary Island lies two miles north-east of Danby and three miles east from the north-east point of Charleton. It is four miles long from north to south, with an average breadth of one mile. On the western side the island is low and swampy, gradually rising inland. On its south, east and north sides are escarpments rising in the highest parts seventy feet above the sea. On the east side a raised beach of some fifteen feet in elevation runs along the shore, and extends inland from one to four hundred yards to an escarpment fifty feet higher, which has a face and top almost wholly composed of water worn boulders, averaging nine inches in diameter, and without glacial striae; they are packed tightly together in a condition similar to that shown by boulders on shoals at present, acted upon by the grounding and shoving of large masses of ice over them. Cary Island.

On the north and south sides, the face of the escarpment is largely composed of sandy clay with large numbers of boulders scattered through the mass. The island on its lower parts is wooded with black and white spruce and a few white birch and poplar, the top of the boulder escarpment is devoid of trees, and has a very barren appearance.

Lying N. 65° E. seven miles from the north-east point of Charleton is the western end of two small islands called the Struttons. The Strutton islands.

The western or larger island is five miles long from east to west, one mile and a-half broad in the middle, and tapering to a point at either end; the smaller island is nearly round, with a diameter of one mile and a-half. The deep channel with its strong current that passes through the Sound between Charleton, Danby, and Cary islands con-

tinues across the open bay on a N.E. course and runs between the Strutton islands, and from these follows on the same course to near the mouth of the East Main River, where it turns northward and is lost along the coast. The channel between the Struttons is one-third of a mile wide, and is obstructed at its south entrance by a small low boulder island one-half mile in circumferance. The current, owing to the confined limits of the channel, rushes through at a higher rate of speed than in the Charleton sound, varying from four to six miles an hour.

The channel, between the Strutton Islands, has been tried as a wintering ground for a ship by the Hudson Bay Company, but it was found that the ice carried along on the strong current caused great damage to the vessel; the crew also suffered greatly from the ravages of scurvy, brought on it is said by the use of the stagnant water in the small lakes on the islands, where no running streams exist.

On all sides of these islands, with the exception of the above narrow deep channel, the water is very shoal, with an uneven bottom covered with sand and boulder shoals, some of which are bare at low water, but the greater number coming within a few feet of the surface, only show their presence by the breakers upon them during gales.

The highest point of the interior of the larger island is seventy-five feet above the sea. On the south side the slope from the highest level is very gradual and is broken by low rounded hills of boulders lying transverse to the shore line, where they terminate in short points: to the westward a raised beach twenty-five feet high, formed chiefly of boulders thickly packed in clay with sandy patches, extends back about one-quarter of a mile to a second abrupt bank of packed boulders thirty feet higher. On the lower beach is an immense rounded boulder of red Laurentian gneiss fully ten feet cube, and consequently weighing over eighty tons.

Raised boulder beaches.

On the east side along the sound and partly on the north side tightly packed boulder banks rise almost perpendicularly ten to forty feet from deep water and resemble, when examined closely, a built, dry stone wall, while at a short distance they have the appearance of an exposure of solid rock. Along the remainder of the shore and inland are immense numbers of boulders in sandy clay, showing that the greater part of the island is made up of them.

The smaller island is low, being formed chiefly of boulder clay with sandy shores covered with boulders on all the points. Both islands are scantily wooded on their lower parts with small white and black spruce and willows; numerous fresh and brackish ponds are situated on these parts also.

Little Charleton Island.

Bearing N.N.W. fifteen miles from the western point of the Strutton's is the eastern end of another small island, at present called Little

Charleton or False Charleton, but named Trodiley Island in Capt. Coates' notes.

This island is very similar in composition and size to the larger Strutton Island, except that it is made up of finer material and fewer boulders than that island. Its greatest length from east to west is five miles and a-half, with an average breadth of one mile. The north-east part of the island is the highest, and rises fifty feet above the sea. On the eastern half of its south side is a raised beach of sand and gravel ten feet high, extending from the water inland from one to three hundred yards, to a steep sloping bank of sand and boulders twenty feet higher, after which the land gradually rises towards the interior. The western part of the south shore is low and sandy and gradually rises inland towards the east, with no cut banks; the western extremity ends in a low, narrow boulder point half a mile long. The north shore is covered with boulders or coarse gravel, except short stretches in the bottom of the small bays which are sandy. Beyond the middle of the north shore, and from there to the east point the island rises abruptly inland, having banks of thirty to forty feet, composed almost wholly of small and large boulders mixed with quantities of clay and sand, from the base of which issue small streams of clear cold water. Springs

The western end of the island is devoid of trees, and shows a barren sandy soil covered with low arctic plants, with numerous large boulders strewn over the surface. The south-eastern portion is covered with small white spruce trees, not more than ten inches in diameter at the base and less than forty feet in height, which grow in open glades, the sandy soil here being covered with deep moss.

About half way between the Struttons and Little Charleton are two small low islands composed of sand and boulders, with low willows growing on their highest parts, many sand and boulder shoals also are to be seen in this part of the bay.

Twenty-two miles distant, on a N. 35° W. course from the east point of Little Charleton Island, is the next high island, with its north end in lat. 52° 30′ 32″, called Weston Island on the present chart of the Hudson Bay Company; this island is named Solomon's Temple in Capt. Coats' notes, while four low islands a few miles to the northward, at present marked Solomon's Temple, he calls Lord Weston's Islands; it is proposed to return to the old names, and call the large bold island Solomon's Temple and the low islands Weston Islands. Weston Island.

Solomon's Temple is a narrow island eight miles long from north to south in the form of a crescent, convex on the west side, and terminating in long, narrow points made up of immense numbers of boulders packed tightly together. On the west side, rising gradually from Solomon's Temple.

either point, is a cut bank of sandy clay full of small boulders, having a face of fifty feet in its highest parts. Behind this bank the surface of the island is an undulating plain, covered with many boulders and dotted with small shallow lakes which fill every depression of its surface. With the exception of a few solitary stunted white spruce, no trees grow on the island, its surface being covered only with low arctic flowering plants, grasses, sedges and mosses. Two miles beyond the north point and seemingly an extension of it, is a small low boulder island about one mile in circumference.

On the northern end of Solomon's Temple great quantities of driftwood are heaped up from ten to twenty and occasionally thirty feet above ordinary high-water mark; on the shores of all the other islands similar piles of wood are found, most abundantly on their north sides; that on the higher levels is generally greatly decayed and composed chiefly of cedar. The presence of these piles of driftwood at such high levels has been taken as evidence of a rapid elevation of the land around Hudson Bay. Dr. R. Bell places the rate of upheaval of the land or "subsidence of the water" at from five to ten feet a century.

Dr. Bell on subsidence of [redacted]

Other evidence than that of the driftwood is required to sustain such a theory, as its presence at these high levels above ordinary tide may be accounted for in another manner than by a rapid elevation of the shores and islands. Owing to the shallow state of the water near the shores of the islands and mainland of James' Bay, the wind, when blowing on the land, has great effect in causing abnormal rises of tide by forcing the water from the deeper parts of the bay over the shallows; an instance in case was observed by the writer while anchored on the east side of Agoomski Island in a moderate gale from the north-west, August 8th, 1887. Here the ordinary rise of tide does not exceed five feet, yet after beaching his boat at 8 p.m., by midnight the water was twelve feet deep showing a rise of seven feet at least above the ordinary level. From this it is easy to believe that extraordinary gales in the late autumn at long intervals apart, would back the water into the bay to such an extent as to cause a rise of tide from ten to twenty feet above its ordinary level. These high tides, accompanied by great breakers, would necessarily throw the older and lighter wood, then on a high level, farther back, and pile newer wood in front and below it, thus forming a state of affairs as at present seen.

Other views.

Other facts tend to disprove a rapid elevation of land around James Bay, at least in its southern part. Capt. Coates, in his notes on the mouth of the Moose River, written one hundred and fifty years ago, describes it as it exists at the present time, with little or no change in the state of the channel or shoals; if a rise of five or ten feet a century

was occurring during this time, the mouth of the river would necessarily be greatly changed, and the shallow flats of Capt. Coates' time would be ten or fifteen feet above the sea. Another place where comparison between levels at different dates can be made is the isthmus connecting the peninsula at the end of the point dividing Hannah from Rupert Bay. At present it is a low muddy neck covered with willows nowhere five feet above high-water mark and distinct from the higher land on either side, which is covered with spruce and tamarac. Now if the change of level claimed were actually taking place, this peninsula two hundred years ago would have been an island with a considerable depth of water over the present isthmus, but on a map (Partie de la Nouvelle France, Hubert Jaillot, 1696) this very peninsula is marked, thus affording good evidence against a rapid change of level of this part of James' Bay.

Between Little Charleton and Solomon's Temple are seven or eight small low islands formed of sand and boulders and covered with low bushes on their higher interior parts; those islands are called the Tiders

The Westons are four low drift islands thirteen miles N.N.E. from Solomon's Temple in lat. 53°. The largest is about seven miles long, and on its western end the Hudson Bay Company had a ship wrecked in 1724. Weston islands.

Thirty-six miles N. 10° W. from Solomon's Temple, in lat. 53° 04′, is the south-east point of the South Twin Island. This island is pentagonal in shape, with its face to the southward; it is seven miles long from north to south, with an average breadth of five miles. Starting from the south-east point, the shore line for one mile and a half northward passes along the base of a steep cut bank of boulder clay, containing an admixture of sand, and varying in elevation from forty to sixty feet. From here the shore turns westward, passing around a bay, one mile and three-quarters wide by one mile and a half deep; the cut bank runs one mile farther inland; low mud flats, covered partly with small blackish ponds, occur between it and high water mark. Again approaching the shore on the north side of this bay the escarpment gradually changes to low rounded hills sloping inland, composed chiefly of boulders, with a shore line as far as the north point formed of numerous boulder points with low muddy bays between, covered with grasses. South Twin Island.

Between the north and west points, four miles, is an escarpment, composed of boulder clay and gravel, forty feet high, running parallel to a shore, alternating between boulder points and sandy bays. From west to south-west point the shore line is low and of the same character as that above, with the ground rising slowly inland. Along the south

side, sand and clay greatly predominate; a cut bank one-quarter of a mile inland gradually rises to an elevation of forty feet near the south-east point, with a lower raised beach of ten feet in front, the latter composed of sand, the former of boulder clay.

The interior of the island rises gradually towards the centre, where it has an elevation of one hundred feet above the sea.

Surface

Small lakes fill all the depressions on its surface. With the exception of some four or five stunted white spruce, less than ten feet high, no trees grow on the island, which is everywhere covered with mosses and arctic plants.

Ice action.

A fine example of the expansive power of ice may be seen half a mile inland from the south east point, where there is a small shallow lake, at present completely drained by a small stream, which has cut out a channel through the escarpment. This old basin is nearly round, with a diameter of five hundred yards, and had a depth of about six feet. Around the old shore line is a bank of boulders and clay, four feet high and eight feet wide at the base, overgrown with vegetation, and resembling the intrenchment of a fortified camp. This has evidently been pushed up by the total freezing of the lake and the expansion of the ice.

Scattered over the surface of the island are great quantities of small angular fragments of light yellowish fossiliferous Silurian limestone, the probable result of the breaking up of large boulders of the same.

North Twin Island.

Separated by a channel five miles wide, and lying four miles to the westward of this island, with its south-west point in lat. 53° 04′ is the North Twin. Like the other island, it has an abrupt escarpment on the east side, with a low shore line on the west rising slowly inland. From the south-west point along the south side, the low shore is composed of sand and gravel, with a wide margin of swampy land extending inland to the slowly rising interior. Low cut banks occur near the coast at the south-east point, where two terraces of ten and thirty feet elevation are seen, the lower formed of sand and gravel, the upper of boulder clay and sand.

On the east side is a wide shallow bay, with low swampy land from a quarter to a half a mile inland to the base of a boulder clay escarpment fifty feet high. On the northern part of the east side a low terrace, fifty feet high, composed of sandy clay, with a few boulders, rises near high water mark, and extends inland on an average a half mile to a second terrace thirty feet higher, and of similar composition. On the north side the land adjoining the shore is made up of sandy dunes dotted with boulders, rising slowly inland, with numerous boulder points along shore. Along the west side the shore margin is low and swampy, with sand and gravel beaches between boulder points, the

latter becoming more numerous to the southward. The banks on this side are generally sloping, with a few cuttings of sandy clay full of small boulders.

Island, the ground rises irregularly towards the centre, where it is lower than the Soutn Twins. The surface is dotted with many small lakes, and covered with a low arctic vegetation.

From the north-east point a low narrow bar of boulders, partly bare at low water, runs out in a north-east direction several miles toward Spencer Island.

The rising and falling tide rushing over this bar forms a strong rapid with heavy breakers. Another reef extends from the south-east point, five miles in a S. by E. direction; a ship was wrecked on it in 1732. On the north point is the wreck of a large sloop belonging to the Hudson Bay Company, lost here in 1886, while under the charge of some Esquimaux engaged in killing white bears on the islands. In the Bay on the east side a small ship's boat, painted white, was found, which must have been lost from some vessel engaged in the whale fishery in the northern part of Hudson Bay, as no such boat has been lost by the Hudson Bay Company.

Walter Island lies ten miles N. 40 E. from the north end of the South Twin. It is nearly round, with a circumference of two miles, and rises with steep banks to an elevation of sixty feet at the highest point. It is almost wholly made up of boulders, which are everywhere tightly packed by ice on the sides and top of the Island. Walter Island.

Between Walter Island and the South Twin, six miles from the latter is a small bare knob of Laurentian gneiss, called Emily Rock, rising in the middle fifteen feet above high water mark, with a circumference of fifty yards. The gneiss is dark flesh red in colour, and made up of dark red orthoclase, with some quartz and black hornblende. It contains lenticular masses of hornblende. Strike N. 30° W. Emily Rock.

Spencer Island is fourteen miles distant from the north end of the North Twin on a N. 50° E. course. This island is one mile and a half long by three-quarters of a mile broad, with a generally steep shore line covered with boulders. On the south side is a sandy bay showing three areas of ten, twenty and fifty feet elevation, the two lower having cut faces of sand and gravel, the highest being formed of small rounded boulders tightly packed together, the same extending over a greater part of the southern interior. On the east side is another sandy bay, with a raised beach of that material fifteen feet in elevation. In this bay twenty-eight empty oil casks were found, which were probably from the same wreck as the boat on the North Twin, the Hudson Bay Company's people knowing nothing about them. To the northward the island is lower and the boulders fewer, with more intermixed sand. Spencer Island.

On the west side a wall of boulders rises directly from the water to elevations varying from twenty to fifty feet. All these islands are frequently visited by polar bears, who land to rest after heavy gales, and feed on the arctic berries that grow in great profusion everywhere; Arctic foxes are also quite plentiful.

The other islands of this group were not examined, but it is inferred from information obtained from the Hudson Bay Company's officer, and Capt. Coat's notes, that they are of similar origin and composition to those above described.

Islands of the third group.

The islands of the third group in James' Bay lie along the east coast, and have been described by Dr. R. Bell in the report of Progress of the Geological Survey, 1877-78, as follows: "The majority of the islands are rather low, and composed of boulders and shingle with few or no trees, but the solid rock occurs upon a large proportion of them. No regularity can be detected in the general arrangement of these islands. They present a kind of labyrinth which it would be very difficult to map with accuracy and which is not unlike that of the Georgian Bay, Lake Huron, except that on the east coast of James Bay the water is shallower, and shews evidence of receding rapidly, and the islands are, as above stated, mostly covered by boulders and shingle."

Meteorological

From the meteorological observations taken during the summers 1887 and 1888, detailed in Appendix No. the following summary is compiled:

Three daily readings with the minimum temperature, taken on fifty-eight days in 1887, while on James' Bay, give a mean temperature of 55 degrees.

Similar readings on fifty-one days in 1888 give a mean temperature of 53 degrees. In 1887, there was fog on twenty and rain on fifteen out of fifty-eight days.

In 1888, fog occurred on twenty-eight and rain on twenty-four out of fifty-one days.

Of one hundred and fifty-three observations on the direction of the wind taken in 1887, twelve were from the N., sixteen from N.-E., four from E., twenty-two from S.-E., seventeen from S., twenty-five from S.-W., twenty-one from W., and thirty-six from N.-W., the resultant direction being due west.

Mean temperatures at Moose Factory.

Two hundred and twenty similar observations in 1888, give a resultant direction of S. 87° W. Three daily readings of the thermometer at Moose Factory during the months of June, July, August and September give the following mean temperatures: 1878, 61·7°; 1879, 54·3°; 1880, 56·2°. These taken with the mean temperatures given above would give an average mean summer temperature of

55·5°. This would be slightly higher than an average for the entire bay, as the mean temperature of Moose Factory is higher than many other places. Dr. R. Bell, in report of Progress 1877-78, places the average temperature of the sea along the east coast at 51°. This is much higher than the temperature of the main body of water, as the water of the east coast is warmed by the rivers flowing into the bay on that side, and being very shallow has its temperature raised by the action of the sun's rays. The difference in the vegetation growing on the outer islands and in the same latitude on the main land shews that the temperature of the former is much lower than that of the latter and this is due to the lower temperature of the main body of water, which is so cold that an immersion of the limbs for a few minutes at any time produces a numbness in the parts of the body so covered.

Big River.

The harbour and mouth of the Big, Kitchisipis, or Mistisipi River has already been described as far as Fort George. At this point the north channel of the river is one mile wide, and for two miles above to the head of Fort George island, it is obstructed by one large and several small islands. For the next four miles the river has an average breadth of three-quarters of a mile, is quite deep and flows with an even current, of about three miles and a half an hour with falling water, the course being N. 50° E. Here a small rocky island and reef stretches across the stream, forming a small rapid. From this point the river bends to the eastward, and for thirty-three miles, in a straight line, flows with a general course of N. 85° W. Three miles above the rapid is the lower of four large islands, which lie on the south side of the main channel, and extend upward six miles and a half past the head of tide. Big River.

Two miles above the upper island the river contracts in width to one hundred yards, and passes over and between a rocky barrier, which causes a fall of ten feet in the form of a low chute with heavy rapids below. Immediately above the chute is a low rocky island half a mile long. From here for nineteen miles the river has an average breadth of eight hundred yards, and flows with an average current of three miles an hour in a deep channel. Beyond this distance is a sharp bend to the north-east for one and a half miles, around the base of a rocky hill, when the former course is again followed for several miles. At the bend, the river is only two hundred yards wide, and consequently has a very swift current, up which canoes require to be tracked. Two miles beyond the bend a portage route of over one hundred miles in length leaves the river on the north side. The river from a few miles

beyond is greatly obstructed by falls and heavy rapids, while passing through a deep narrow gorge, where the rocky banks are so steep that portages cannot be made, thus rendering its navigation with canoes impossible.

Few tributary streams enter the river below the portage. Among the larger is a small river from the north, flowing in behind the islands, about two miles above Fort George. The next is on the south side behind the lowest island at the head of tide. One mile and a half above the chute is a small river, thirty yards wide at its mouth, coming from the south and called the A-che-gi River. Three miles and a half, and seven miles above the last on the same side, are two large brooks named respectively A-na-mis-cat and Ni-min-se-tat Rivers. Four miles below the bend a small river twenty yards wide at its mouth, called the Ne-co-pa-stick, also flows in from the south; at the bend a large brook descends in a beautiful fall from the rocky hill to the eastward, while in the upper bend and at the portage two large brooks enter from the north. From its mouth to the portage the river flows in a valley cut out of stratified marine clays and sands of Post Tertiary age. The banks on the islands and shores near the mouth of the river are composed chiefly of bluish white clay overlaid by a thin deposit of yellow sand, showing out faces on the islands and at intervals along the shore ranging from ten to thirty feet in elevation above the river. A few miles up the river the banks become higher with thicker deposits of sand on top. Just above the first rapid an exposure on the south bank gives thirty feet of clay and ten feet of sand.

Hay flats. On the islands at the head of tide the banks rise fifty feet above the river. At this place, on the north shore, are extensive low flats covered with marsh hay. This is cut and transported to Fort George in large boats and used to feed the cattle kept there during the winter. Above the chute, the banks are often over sixty feet high, with forty feet of stiff blue clay at the bottom, overlaid with sandy clay and sand.

Fossils. Everywhere the lower clay beds hold fossils, the following being the species found: *Tellina grœnlandica*, Beck, *Saxicava rugosa*, L., *Mya arenaria*, L., *Mya truncata*, L., *Buccinum tenue*, Gray, and *Mytilus edulis*, L. The upper sandy clay and sand beds contain very few fossils, *Saxicava rugosa*, being only sparingly seen in them.

Boulder-clay. At the bend below the portage, on the east side of the river, is a deposit of boulder-clay, cut by the river, and showing a face of over seventy-five feet in height. This was evidently deposited by the glacier behind, and protected by the steep gneiss-hills seen a short distance to the eastward; the boulder-clay forms a tail to those hills. The coun-

try on either side of the river, above its banks, is a slightly rolling plateau of sand and clay, rising slowly inland, and broken through by low, rounded knobs of gneiss. The greater part of this country has been burnt over, and in such places is covered with a small second growth of black and white spruce, aspen poplar and tamarac, with Banksian pine predominating on the sandy portions. None of these trees exceed fifteen inches in diameter three feet from the ground. On the unburnt portions and along the river valley the trees are larger, some being eighteen inches in diameter fifteen feet from the ground. Here are found white and black spruce, balsam and aspen poplar, small white birch, tamarac and a few balsam spruce. Timber.

On the lower stretches of the river occasional low exposures of gneiss outcrop from beneath the clays. As the stream is ascended these rise higher and higher, until, upon the upper part, they form bold hills, rising at intervals above the sands and clays. The following are the different exposures noted while ascending the river: On the north shore, opposite Fort George, and below to the mouth of the river, are a number of rock exposures, consisting chiefly of pink and grey fine-grained orthoclase hornblende-gneiss, along with a coarse pink hornblende-gneiss holding large porphyritic crystals of bluish-white triclinic felspar. Everywhere throughout these exposures are enclosures of lenticular and partly rounded masses of fine-grained rock, composed chiefly of black hornblende, probably segregations from the main mass. Strike N. 80° W. Rock exposures along river. Gneiss.

On the south shore, behind Fort George, near the head of the island, are finely-bedded bands of a dark fine-grained hornblende gneiss, made up of black hornblende and buff-weathering felspar, with little or no quartz. Along with these are lighter bands, in which orthoclase predominates. Strike N. 85° W.

At the mouth of the south channel are exposures of a dark hornblendic rock, netted by veins of lighter fine-grained gneiss, forming a breccia; also coarse, greyish pink gneiss, made up chiefly of large, pale crystals of orthoclase and dark hornblende, with very small quantities of quartz. Strike N. 72° W.

At the island in the first small rapid the rock is light grey and pink orthoclase hornblende-gneiss, containing lenticular masses of fine-grained hornblende-schist. Strike N. 68° W.

On the south shore, at the chute, is coarse grey hornblende gneiss, with thin bands and fragments of hornblende-schist, followed by thick beds of massive hornblende-schist, interfoliated with thin bands of light orthoclase-gneiss; then grey and pink gneiss, with a dark-red variety, made up of flesh-red orthoclase, black hornblende and quartz. Strike N. 75° W.

On the north side the rock is a dark, granitic, orthoclase hornblende-gneiss, associated with thick masses of dark-green hornblende-rock, containing grains of magnetite; the source of the colors of iron-sand frequently seen along the river shore.

At the chute are two dark-green trap dykes, weathering reddish-brown, which run S. 66° W. and S. 47° W., being respectively four feet and nine inches wide. On the north side, one-quarter of a mile below the chute, is a similar dyke, eighteen feet wide, running S. 75° W.

Three-quarters of a mile above the chute is an exposure of hornblendic schistose gneiss, composed of alternate laminæ of blackish, green hornblende and yellow weathering, grey felspar with patches of reddish orthoclase. In some parts the rock is a dark, fine-grained, hornblendic gneiss, with large porphyritic crystals of whitish felspar, the largest crystals being one and a-half inches long by one-half inch broad, with their longer axis always parallel to the plane of stratification. Strike S. 75° W.

Five miles beyond the last, on the south bank, is a fine-grained, bluish grey gneiss made up of dark hornblende and bluish felspar, with little or no quartz, containing enclosures of dark hornblendic segregations. Strike S. 60° W.

One mile and a-quarter above the last there are exposures of fine-grained dark-grey hornblendic gneiss, weathering greyish yellow, containing porphyritic crystals of white felspar, and traversed by veins of pink orthoclase also having hornblende segregations.

Three miles beyond was seen similar hornblende gneiss, with massive hornblende rocks like those at the chute, also light pink highly felspathic gneiss containing much less hornblende and more quartz than the darker grey rock. Strike N. 85° W

One mile farther up is more of the dark grey hornblendic gneiss and black massive hornblende rock.

Three miles and a-quarter beyond the last are exposures of the porphyritic gneiss. Strike E. by W.

At the small rapid on the bend below the portage is a coarse red and grey gneiss, composed chiefly of red and grey orthoclase, crystals of which are perfectly developed, along with slightly altered dark-green hornblende and some mica and quartz. Strike S. 77° W.

Portage Route between Big and Bishop Roggan Rivers.

Big River to Bishop Roggan River.

Leaving Big River at the portage, the route passes overland, on a general course of N. 40° E. by a number of portages connecting small lakes, draining into Big River through a large lake on a river which flows into James Bay a few miles north of the mouth of Big

River, and thence by two portages into a large lake on the Bishop Roggan River.

The following details show the difficulty of taking canoes over this route.

The first portage from Big River is three miles and four chains in length, and passes almost directly north, ending in a small lake one-quarter of a mile broad, joined to another small lake by a brook five chains long; the second lake is thirty chains across.

Succession of portages.

From it the next portage, of five chains, was made to another small lake, half a-mile wide, followed by a portage of sixty-seven chains ending at a similar lake half a mile long, succeeded by a portage of seventy chains, then a lake of fifteen chains, followed by a portage of forty-six chains, a lake of ten chains, and another portage of seventeen chains, to a slightly larger lake called Wa-we-cho-to-chis, where the Indians, while traversing the portages, stop to fish. This lake is two miles long from the upper end to its discharge, a small sluggish brook obstucted by beaver dams. The route follows the winding course of this stream for half a mile to a portage three miles long, ending at a small lake three-quarters of a mile broad, followed in succession by a portage of thirty chains, a lake of twenty chains, a portage of forty-one chains, a lake of forty chains, a portage of forty chains, a lake of one mile, a portage of fifteen chains, a lake of fifteen chains, and a portage of twenty chains, to the banks of a small river tributary to Big River. This stream was ascended one mile and a quarter past three small rapids to Lake A-wi-chi-na-wi-ga-chi, a large body of deep clear water well stocked with fish, an abundant supply of pickerel, pike, white fish, and suckers being taken in the net here. This lake has two bays extending from its outlet, the western bay is several miles long, the northern one was followed three miles to its head, where a sluggish stream fifteen feet wide was ascended one-quarter of a mile to a lake thirty-five chains wide, followed by five portages of thirteen, thirty-six, eight, fifty-five, and eighty chains long, connecting lake traverses respectively of twenty, twenty-five, and one hundred and twenty-five chains to Pi-a-go-chi River, at this point a shallow rapid stream one hundred feet wide. This river empties into James Bay near Wasticoon, a high rocky island about eight miles north of the mouth of Big River. From the portage a short rapid, full of large boulders was ascended for half a mile and Pi-a-go-chi Lake entered near its western end. This is a long, narrow lake surrounded by low rocky hills in many places rising abruptly two hundred feet from the water. The route follows its eastern bay four miles and a half, and leaves it by a portage on the north shore several miles from its eastern end. The portage is fifty-five chains long and passes over two rocky

ridges, ending in a small lake fifty chains across, followed by another portage of forty-three chains to a large irregular body of water called A-pi-cho-ti-ne-chits Lake, which is drained by Bishop Roggan River.

Character of country on route.

Between Big and Bishop Roggan rivers the country is made up of ridges of low rounded gneissic hills rising from fifty to two hundred feet above the general elevation of the land, which is estimated from an average of the barometer readings taken, to be six hundred and seventy-five feet above sea level. These hills are partly covered with boulder sands and clays, while the intervening valleys are filled with deep mossy swamps and small lakes.

Timber.

The greater part of this region has been burnt over by frequent fires, which have in many places left the higher parts totally devoid of vegetation. The trees remaining are second growth black spruce, tamarac and banksian pine, never exceeding fifteen inches in diameter three feet from the ground. On the lower swampy lands and around the margins of the small lakes, where the fires have not destroyed the older trees, a dense growth of small black spruce and tamarac prevails with an occassional balsam spruce. On the portage leading from Pi-a-go-chi Lake, a few balsam poplars, four inches in diameter, were seen along with small red cherry trees, this being the northern limit of the latter.

Except in the immediate vicinity of Big River no stratified superficial deposits occur on this portion of the route. The sands and clays seen were unstratified and mixed with boulders. On the higher ground sand predominates, owing probably to the greater part of the clay being washed out of the thin deposits there overlying the rock, and carried down into the lower valleys, where the clay is greatly in excess.

Rocks along route.

On the first portage from Big River are exposures of pink and grey coarse-grained hornblende orthoclase gneiss. Strike S. 60° W. Similar gneiss, highly contorted, is seen on the second portage. Coarse pink hornblende orthoclase granitic gneiss, containing angular fragments of dark, fine-grained hornblende schist was seen on the third portage. On the fifth portage similar gneiss occurs along with a pink micaceous variety. Strike E. and W. Highly contorted pink and grey hornblende and mica gneiss, having a general strike of S. 20° W., is exposed on the seventh portage. On the eighth and ninth portages the rock is more micaceous, with great numbers of barren quartz veins. On the latter portage, fifteen chains from the south end, is a dark green diorite dyke, weathering deep brown, with a fine-grained compact structure near its contact with the surrounding gneiss, but rather coarsely crystalline in the mass. This dyke is two hundred and thirty feet wide and runs N. 27° W.

Similar pink and grey hornblende mica gneisses were seen on all the portages to the fifteenth, where they occur associated with grey hornblende gneiss, holding porphyritic crystals of grey felspar, like that described on the Big River.

On the portage from Pi-a-go-chi Lake the rock is chiefly composed of a fine compact pink graphitic gneiss, made up of orthoclase and quartz, with very small quantities of mica and hornblende. The quartz and orthoclase are arranged in alternate laminæ averaging one-eighth of an inch in thickness. Strike N. 77° W.

On the next portage are similar rocks along with coarse-grained pink micaceous gneiss. Strike S. 87° W.

South Branch of the Bishop Roggan River.

The name Bishop Roggan is a corruption of the Indian word pi-chip-oui-an, meaning fishing weir, from the immense willow weirs, with basket sluices, built across the stream by the Indians to catch fish descending the river.

Lake Ab-pi cho-ti-na-chits, as before stated, is a large irregular body of water, full of islands and indented with many deep bays, the shape and size of which can only be ascertained by surveys of each, taking more time than could be afforded on a hurried trip over so extensive an area of country. From the last portage the route passes northward one mile and a half down a narrow bay, to a long, low point, crossed by a portage of six chains in length. Thence an irregular course between islands is followed for four miles in a general N.E. course to the outlet, where the river, fifty yards wide, is descended three-quarters of a mile, past a small rapid to Lake Ko-tan-i-wau-an. This is another large lake covered with islands, the river flowing out of its north west end. Its south-eastern shore was followed, two miles and three-quarters to the mouth of a small branch stream. The country around these lakes is comparatively flat, with low rounded gneiss hills, rising at intervals from fifty to one hundred feet above the swampy low lands. Description of route by south branch

The route passes up the small branch on a directly east course for three miles and a quarter to a fall eight feet high, where the river is ten yards wide. Between the fall and the lake below, the river, with an average breadth of two hundred yards, flows between low rocky hills, which rise from the water's edge, forming an irregular shore line. Above the fall, the valley is wider, the river or lake, here averaging four hundred yards in width, is broken into a great number of small bays, by low narrow points extending out from the base of the rocky hills.

To Pi-mi-ga mu-chi Lake, four miles, the course is N. 70 W. This lake is several miles long from east to west, by about one mile broad; the route leaves it by the river that flows in on its north side, two miles and three-quarters from the outlet, and passes N. W. up that stream three miles to Lake A-wah-a-gets, with two portages past small rapids. From here the river turns S. 78 E., for seventeen miles, to Lake O-ho-mi-chi-chits, passing through seven narrow lakes connected by small rapids, where the stream is too small and shallow to ascend with canoes. Lake O-ho-mi-chi-chits is cut into three bays by long rocky points; it was traversed in a general S. 50° E. course to its head, the distance being six miles. Here a low rocky portage, thirty-four chains long, crosses the height of land between Bishop Roggan and A-pa-chi-chits river, a tributary of Big River; the portage ends at a small lake forty-three chains long. Descending the small brook flowing out of it, for ten chains, another small lake, thirty chains long, is passed through to a portage of twenty chains, over a steep hill to a lake of one hundred chains. The discharge is full of small rapids and causes a portage of half a mile, at the end of which is a navigable stretch of forty chains, followed by more rapids and a portage of eighty-six chains, after which the crooked course of the river is followed for eighty-eight chains to Lake Ka-bun-ski-wus, which is six miles long, with numerous deep lateral bays. From the outlet of this lake the river is again followed two miles and three-quarters, through two small lakes with rapids between, to a portage of one hundred and thirty-two chains, passing south over a ridge of hills and ending at Sha-tach-i-wan Lake, through which the Big River flows. The A-pa-chi-chits River, below the portage, passes through a deep gorge, and enters this lake one mile and a half east of the portage, by a fall sixty feet high.

Portages.

Character of country.

As the small branch stream from Lake Ko-tan-i-wan-an is ascended, the country becomes more and more rocky and rough, with long ridges of hills running parallel to the river valley, massed closely together, having but small areas of swampy valley land between. The elevation of the hills above the surrounding water level varies from fifty to one hundred and fifty feet, as far as the water shed. Beyond this the hills rise from one hundred to two hundred and fifty feet above the general level to Lake Sha-tach-i-wan. These hills have for the greater part been recently burnt over, so that nearly everywhere they present the scorched bare surface of the rock, partly covered with boulders, and scattered over with the standing blackened trunks of trees; the whole having a very desolate, barren look. On the unburnt portions small black spruce and tamarac predominate along the lower parts of the branch, but are in a great measure replaced by small banksian pine as Big River is approached. A few small white birch and aspen pop-

Timber.

lar grow along the hillsides near Lake Ka-tan-i-wan-an. The northern limit of the mountain ash (*Pyrus Americana*, DC.) was reached on Lake Pi-mi-ga-ma-chi, where a few low trees were observed. Everywhere in the depressions and valleys between the hills are deposits of boulder clay, while scattered over the hills are immense quantities of boulders. A curious ridge of packed boulders, forty feet wide, and rising from five to fifteen feet above the general level, was seen running N. 10° E. from the inlet of Lake Pi-mi-ga-ma-chi over a low hill. It was traced for a distance of one mile to the edge of a deep swamp and apparently continued over the hill on the other side of the swamp. Boulders.

The rock throughout is chiefly a red syenitic gneiss, often granitic in structure, composed of red orthoclase, black hornblende, with little or no quartz. Rocks.

At the fall above Lake Kotaniwanan the rock is a coarse pink hornblende orthoclase gneiss. Strike S. 77° W.

On an island in Lake Pimigamachi similar gneiss is exposed. Strike S 85° W. At the bend in Lake Awahagate is more of the same rock without signs of stratification. On the portages past the rapids of the seventeen mile stretch to Lake Obomachichits are exposures of pink hornblende orthoclase granitic gneiss. On the height of land portage the rock is coarse and fine grained pink hornblende gneiss. Strike S 88° W. At the second rapid below Kabunskiwas Lake are exposures of fine grained, highly contorted, micaceous orthoclase gneiss, showing pink and grey bands. On the summit of the portage to Shatachiwan Lake is a coarse-grained grey hornblende gneiss, containing porphyritic crystals of pale pink orthoclase.

Upper Big River.

Shatachiwan Lake is about seven miles long from east to west, with a wide bay on the south side, out of which the Big River flows. For three miles from its eastern limit, the lake has been filled up by alluvium brought down by the river. This forms a delta of low islands covered with willows and separated from each other by narrow shallow channels. Route by the Upper Big River

In ascending the river from the lake its courses are: First, N. 60° E. for ten miles and a half, then N. 30° E. for two miles and one quarter, bending then to north for two miles, then N. 30° W. for three miles and a quarter, followed by N. 60° E. for four miles and S. 60° E. for three miles and three-quarters; lastly N. 65° E. for fourteen miles, where the route leaves the river by a small tributary called Pa-ti-ta-wa-gau River which flows in from the north.

For the first few miles above the delta the river flows with an even

current of about three miles per hour, between low, muddy banks, and has an average breadth of four hundred yards.

Falls and [illegible]

Two miles above the lake is a low island three-quarters of a mile long, with two smaller islands at its head. One mile beyond the island is a rapid one-quarter of a mile long with three feet rise. Above the rapid is a broad quiet stretch of nearly a mile, to a chute of ten feet, where the river falls over horizontal ledges of gneiss. The portage past this chute is eleven chains long. Seventy chains above is another chute of fifteen feet, passed by a portage of thirteen chains, and followed by quiet water for three miles and a half to a small rapid one quarter of a mile long, with more good water for two miles to a chute and rapid of forty feet. Between the last two chutes the river is obstructed by a number of small islands, fourteen in all. The portage past the forty-foot chute is half a mile long and is followed thirty chains above by another of fifteen chains past a fall of thirty feet. From here around the western bend, a distance of four miles and a half, the river is easily navigable with canoes past four large islands to a fall of thirty feet. Beyond this no obstacle occurs in the navigation of the river to the Patitawagau branch, up which the route passes. According to the statement of the guide the river, for a great distance beyond, is free from rapids and is quite easily navigable with canoes. About the last portage the stream averages two hundred yards in width, is comparitively shallow, and flows with a uniform current of between two and three miles per hour.

Tributaries of Upper Big River.

The first large tributary of Big River above Shatchewan Lake is called the Man-i-wan River and flows in from the north one mile and three-quarters above the fifteen feet chute. It is fifty yards wide at its mouth. Two miles and a quarter above, another large branch called Wa-cha ti-mi River enters from the eastward, and is seventy yards wide at its junction with the main stream. Several small brooks fall into the river on both sides between this point and the big bend to the east, where two small rivers, whose mouths are one mile apart, enter from the north; these are named Mes-ta-oh River and Fishing River, the former is ten and the latter twenty yards wide. Another northern branch called the Ka-o-chi-so-wi sto River flows in immediately above the thirty feet chute, this stream is forty yards wide at its mouth. Only one other river, the Ka-wa-chi-wan entered between the last and the Patitawagan. The Kawachiwan flows out of a large lake on the high lands a short distance to the north of Big River and enters the valley by a beautiful fall of fifty feet.

As has been already stated, in passing from the northward to Shata chewan Lake, a sudden fall of over one hundred feet takes place in the general surface of the country. The higher plateau with its rolling

hills trends from the lake towards the north-east, and forms a distinct wall to the wide, flat plains through which the Big River flows.

Above the lake the river has cut out a shallow channel through deposits of non-fossiliferous stratified sands and clays, which on the lower reaches sometimes show cut faces of pure sand, occasionally overlying thin deposits of clay without boulders. Beyond the river valley the country is almost flat, with a few isolated ridges of gneiss rising from fifty to one hundred and fifty feet above the general surface. At the chutes and rapids these ridges cross the river. Stratified sand clays.

Above the upper chute the river approaches the high rocky land on the north, along the base of which are two terraces rising twenty and fifty feet above the present river level. Where examined they were found to present faces of stratified sand and fine gravel in many places overlying beds of fine blue clay. Above Kawachiwan River the hills also approach the river from the south, and along their base similar terraces rise ten, thirty and fifty feet above the river. Terraces.

The deposits in which these terraces have been cut are of fluviatile or lacustrine origin. The river at the close of the glacial period was probably dammed in various places with drift barriers which caused it to cover the wide flat valley between the higher rocky hills with lake areas in which the clays, sands and gravels were deposited.

Where the terraces are close to the higher rocky hills, their surface and faces are strewn with boulders evidently rolled down from the higher elevations where they thickly cover the rocky surface; at points distant from the hills no boulders were observed on the terraces.

Along the river valley and on the islands, the trees are chiefly black and white spruce and tamarac, with some balsam poplar and balsam spruce. Many of these trees are eighteen inches in diameter, three feet from the ground. On the higher parts out of the river valley the trees are smaller, and are black spruce, banksian pine and tamarac. Timber.

The country composing the river plain is generally swampy. Just above the delta of Shatachewan Lake, on the south bank, is an exposure of coarse, grey, garnetiferous hornblende-gneiss, penetrated by numerous veins of pure red orthoclase. Strike N. 47° E.

At the first rapid above, the rock is a fine-grained grey mica-gneiss, followed by coarse-grained, grey hornblendic-gneiss, holding porphyritic crystals of pale-pink orthoclase. Rocks.

At the ten-foot chute is a very coarse-grained grey gneiss, with well developed crystals of hornblende and orthoclase; along with it are small bands of fine-grained, pink, orthoclase-hornblende-gneiss, penetrated by many large veins of quartz and orthoclase, holding red garnet and black tourmaline crystals. The bedding of these rocks is

apparently horizontal. On the portage past the fifteen-feet chute the same rocks were seen dipping S. < 70°.

At the rapids, three miles and three-quarters above, the rock is a fine-grained, grey hornblende-gneiss. Strike N. 40° W.

On the portage at the forty-feet chute are exposures of highly contorted, pink and grey, fine-grained hornblende-gneiss.

At the twenty-feet chute similar rocks were seen.

A micaceous hornblendic-gneiss, greyish-green in color, along with pink bands of the same, holding segregations of hornblende and cut by veins of pink orthoclase, occur at the thirty-feet chute. Beyond this, to Patitawagan River, no rock exposures are seen in the river valley.

Portage Route from Big River to the South Branch of Great Whale River.

Description of route.

Leaving the Big River by the Patitawagan River, the route passes up that crooked stream in a general north-west course for fifty chains to a portage of half a-mile over a sandy plateau, sixty feet above the river valley, past a shallow rapid. Thence the winding course of the river is again followed two miles and three-quarter, past small rapids, causing portages of four, thirty-six and twenty-seven chains, to a small lake called Ka-wa-cha-ga-mi-chits. The river winds through a valley half a mile broad, cut out of stratified sands, on the lower parts showing cut faces sixty feet high. As the rate of fall of the river is heavy, these consequently become lower as the stream is ascended, until, near the lake, they have disappeared, giving place to rocky hills, partly covered with a thin layer of boulder-clay.

Lake Kawachagamichits is two miles long, with an average breadth of half a-mile. It is separated from another small lake forty-five chains long by a portage of six chains, with a similar portage at its upper end to A-chē-wa-ma-ni-ka Lake, out of which the Patitawagan River rises. This last lake is two miles and a-half long, with an average breadth of one-quarter of a mile, and is very deep. The waters of these lakes and the following ones are remarkably clear and cold, and are plentifully stocked with large white fish, lake and river trout, pickerel and suckers. The next portage is fifteen chains long, and forms the watershed between Big River and the north branch of Bishop Roggan River. The course, in a straight line from the mouth of the Patitawagan River to the height of land, is N. 50° W.

Character of country.

The country about the lakes is very similar to that described on the south branch of the Bishop Roggan River; it is made up of low rounded ridges of hills, rising from fifty to two hundred feet above the water level, with the intervening valleys covered with small lakes or mossy swamps. Everywhere are immense quantities of rounded

gneiss boulders; these constitute about three-quarters of the loose material which covers the rocky surface of the hills, and fills the valleys.

From the height of land portage, Ni-a-wa-ta-wi-ga-chi Lake is followed seven miles and a quarter in a N. W. direction. This is a long narrow lake, with numerous small natural bays, branching at its western end into three deep bays. The route passes to the discharge at the head of the western bay.

Here a portage of thirteen chains passes a rapid on the small stream flowing out. Following down this stream three miles and three-quarters on the same course, crossing portages of five, seventeen and fifteen chains in length, past small rapids, Lake Ka bi-pi-ka-mow is reached. The eastern bay of this lake is followed for three miles, when the route turns northward up a narrow passage into a large bay, running north and south, and follows the north arm of this bay to its head, three miles from the main lake. Here a portage of five chains crosses to a small narrow lake, ten feet higher than the last, into which it discharges by a small stream. The route follows up this lake one quarter of a mile to a portage of eight chains, that ends in a small lake fifteen chains across. A portage of twenty-two chains leads thence to a larger lake one mile long, separated from another lake, one mile and a half long, by a portage of six chains. The portage out of the upper end of the last lake is on the height of land between Bishop Roggan and the south branch of Great Whale River. The country passed through, drained by Bishop Roggan River, is very similar to that previously described, with lower hills averaging from twenty-five to fifty feet above the level of the water, and never exceeding one hundred feet. Portages.

Much more swampy land lies about the various lakes. Everywhere the hills and valleys are covered with innumerable boulders often perched upon the very summit of the hills.

The trees continue to decrease in size; they average six inches and are never over twelve inches in diameter three feet from the ground. They are black spruce and tamarac, with fewer banksian pine; a considerable number of very small white birch were seen on the rocky hill sides about the lakes. Timber.

The rock at all the exposures examined on the portages and along the lake shores was everywhere found to be a moderately coarse-grained, pink, hornblendic orthoclase gneiss: often granitic in structure, and frequently holding segregations of hornblende. The general strike, when seen, was about N. 60° W. Granite gneiss.

Upper Great Whale River.

Description of route followed.

Great Whale River heads in a small lake, half a mile long, separated by a short portage of ten yards from Lake Ka-hi-pi-ta ni-cow, a large body of water covered with small rocky islands, and nearly divided by a long point running out from the east side. The route passes through this lake around the point, a distance of three miles and a half to a portage of twenty-five chains, which connects it with Ma-squa chi-wi Lake. This lake is divided by ridges of hills forming long points into three bays; these lie in troughs parallel to the strike of the rocks, here N. 50° W.

The route crosses the two western bays, and passes up the eastern one to its head, the distance being four miles and one-half. From here three portages of six, twenty-three and thirty-four chains, with connecting small lakes of fifty-eight and twenty-five chains were passed over to Mis-him-in-i-we-tau Lake. The descent on the last portage is one hundred and sixty feet.

This lake, like Misquachiwi, is divided by rocky ridges into several long narrow bays parallel to the strike of the rock.

The portage reaches it at the upper end of the north-east bay, near the inlet of the river, which falls into it through a deep rocky gorge. This bay, with an average breadth of half a mile, runs ten miles in a direct N. W. course, to a long point separating it from a similar bay on the north side. The hills on either side of the bay rise on an average three hundred feet above the water, with numerous peaks one hundred feet higher; those on the south side slope gradually to the water's edge, while on the north they rise abruptly in rocky cliffs directly from the lake.

Beyond the point the route runs more to the northward, and in two miles and a half crosses the second bay, passing along the shore of a large island, through a narrows, into another deep bay running towards the north-west. Following along the east side of this, one mile and three-quarters, the outlet was reached, and a rapid of fifteen chain descended into Ka-bi-ma-chi-wan Lake, entering it about the middle, one mile and three-quarters from its outlet.

Leaving the north-east bay of Mishiminiwetau Lake the hills become lower, with the ridges farther apart, and consequently the amount of low swampy land is much greater.

A rapid, ten chains long, with a fall of four feet, connects Kabimachiwan with Ka-chin-wa-ste-gin Lake, the river here is thirty yards wide. The north shore of the latter lake was followed three miles and a quarter to a portage, which leaves the lake from the head of a small bay near its north-west end, where the river flows ont. This portage

is fifteen chains long, and crosses a low rocky ridge, ending in a small lake half a mile across to the outlet, where the river is again obstructed by heavy rapids, causing a portage of fifteen chains, to another lake partly covered with many islands.

Here an east course was followed for one mile and a quarter past a long narrow point projecting from its west side, then turning north two miles and a half, the outlet was reached, and the river, here forty yards wide, descended one mile and three quarters past small rapids to Pos-pis-ka-ga-mi Lake. One mile to the east of the entrance of the river another large stream called Ka-mo-chi-mo-pas-ti-quo River enters. This lake is four miles long from south-east to north-west, with an average breadth of a mile and a half. Its western shore was followed three miles to the river flowing out.

Beyond this the river passes through no more lakes and flows in a distinct valley.

The country surrounding the last lakes is nearly flat and very swampy, with a few low ridges of hills, littered with large quantities of rounded boulders. The trees continue to grow smaller, and are almost wholly confined to the valleys and low lands. Black spruce predominates with some tamarac, and a very few banksian pine. Timber.

On the portage to Masquachiwi Lake the rock is a coarse-grained pink hornblende gneiss. Strike N. 10° W. A fine grained compact pink hornblende mica gneiss, holding dark hornblendic segregations, striking N. 70° W., was seen on the portage to Lake Mishiminiwaten. On the large island in that lake a fine-grained reddish grey mica gneiss occurs strike N. 75° W. Exposures of red and grey fine grained mica gneiss are to be seen at the rapid above Kachinwastegin Lake strike N. 82° W. On the portage below the same lake, the rock is a grey fine-grained, mica hornblende gneiss, cut by large veins of light pink orthoclase. Strike N. 75° W. Rocks.

At a small island in Pospiskagami Lake is a dark red fine grained mica gneiss made up largely of flesh red orthoclase, strike N. 72° W.

Lower Great Whale River

The river where it leaves Lake Pospiskagami is one hundred and fifty yards wide, is quite shallow, and for two miles and a half flows with a swift current between low rocky banks, cut by numerous small bays. Here a rapid of eight feet is passed by a portage of fifteen chains; followed by another stretch of swift water for two miles and a half to a fall of eight feet. Below this, the river is three hundred yards wide and very deep, passing N.W. three miles through a straight gorge with rocky hills on either side, which rise from two to three hundred Character of river.

feet above the water; these hills are bare on top, with small black spruce trees growing along their bases on the river bank, and in the small valleys between the hills. The rock surface on the hills is covered with blackish lichens (tripe de roche), which gives it a dark purple color when seen from a distance. Below this gorge are two falls fifteen and eight feet, half a mile apart; these are passed by portages of twenty-one and two chains respectively. Below these a similar quiet stretch of three miles is passed, when the river suddenly turns round the foot of a hill three hundred feet high, which stands directly in the course. In passing this hill the river contracts and is broken by a fall of thirty feet. The portage here is twenty-two chains long, and passes up a valley between the hill and the highland on the west side.

Below this fall the river turns N. 60° W., and flows three miles and three-quarters past a small branch from the west, called Ka-min-a-squa-ga-ma-stick River. At the end of this course another small branch from the west also enters. The Indians, when coming from inland by the river, to avoid the rough part immediately below, ascend this branch some distance, then pass by a portage route through several small lakes, and reach the river again seven miles below. For four miles and three-quarters from the last course the river runs north in a narrow valley between rocky hills, rising abruptly from 200 to 400 feet above the water. In this distance no fewer than seven portages, of fifteen, four, fifty-five, thirty, fifteen, seven and fifteen chains long, are made past falls and rapids of six, five, sixty, thirty, eight, thirty-five and twenty feet fall respectively.

Seven portages.

Immediately below these the river again turns north-west, and is a continuous, shallow rapid for two miles and a-half. This is very difficult to descend in canoes, on account of the great number of large boulders which block the channel.

At the foot of the rapid is the lower end of the Indian canoe route. From here the river, with an average breadth of 100 yards, flows along at the rate of four miles per hour, between slightly lower hills, for five miles on the same course, to its junction with the main or north branch, which is 400 yards wide, and was seen flowing directly from the west from the base of a range of hills upwards of ten miles distant. Below the forks the river is over 400 yards wide, and flows to the north for two miles and a-quarter. Here the stream contracts to about fifty yards in width, and passes down through a cañon, whose walls rise perpendicularly 400 feet above the water. The total descent in two miles is 230 feet. At the head of the cañon are two falls of thirty and sixty feet, with a third one of fifty feet one half mile below. The rest of the descent is gradual, and consequently the pent up water

rushes through the gorge in a mass of foam, with huge waves rising thirty and forty feet high, the whole forming a wonderfully wild and grand scene.

The portage past this obstruction passes over the hills on the west side, and is rather more than two miles long. Leaving this gorge, the valley gradually widens out to half a-mile, and the river again flows towards the north-west, with an even current of three miles an hour, for eight miles and a-half, where, again narrowing to 100 yards, it takes a short bend to the east, and again to the north for three-quarters of a mile, where it breaks through a range of hills rising 500 feet above it, and falls sixty-five feet over a sharp ledge. Turning westward, and again widening out to one-third of a mile, the river flows at the rate of four miles per hour in an uninterrupted course, ten miles, to its mouth. Portage two miles.

Below the forks the hills along the river rise from three to five hundred feet in elevation above its surface. They reach their highest altitude near the last fall and then gradually decrease towards the coast where they average about three hundred feet. No stratified drift deposits were seen along the sides of the river valley until the Indian portage route was reached. From here, stratified sands and gravels of fluviatile origin were observed on the hill sides up to elevations of one hundred feet; above this the small amount of loose material is wholly boulder till. The erratic boulders are not scattered so thickly over the bare hills as they are farther inland. From the forks along the valley to the cañon, stratified sand and gravel are deposited along the hill sides up to an elevation of one hundred feet where a marked terrace is observable.

Below the cañon the river has cut banks varying from twenty to fifty feet high. The lower parts of these are composed of about thirty feet of light blue clay overlaid with ten feet of sand, which in turn is in places capped with a thin deposit of gravel. No fossils were found in these beds, although they are probably of marine estuarine origin like those nearer the mouth of the river.

From the lower fall to the mouth of the river the channel is cut out of deposits of clay, capped with sand, which form a terrace of seventy-five feet elevation in the valley between the rocky hills. The clay beds are full of Post Tertiary marine fossil shells: the sand above holds no fossils. Between the rocky hills and the sea shore on the north side of the river is a sandy plain two miles broad and one hundred feet high at the base of the hills, it slopes away to the shore, is covered only with coarse grass and is wholly devoid of trees.

On the south side a like plain fills a broad valley between the inland hills and those forming the south point of the river. The head of tide

is eight miles above the mouth, the river is here obstructed by three small boulder islands, with two similar islands below.

The vegetation on the lower part of the river is almost arctic in character, the only trees are stunted black spruce and a few tamaracks, which grow on the terraces and in valleys and crevices between the rocky hills.

Snow and ice.

At the end of July many patches of snow and ice were seen on the north slope of the gorges in the hills facing the river. At the first portage below Pospiskagami Lake the junction between the coarse-grained pink hornblendic gneiss and a band of dark-green chloritic and altered hornblendic rocks of Huronian age was seen. Near the line of contact the Laurentian gneiss is highly twisted and shattered, so that fragments are seen embedded in the massive schistose, chloritic rock, lying at right angles to the line of contact. Offshoots from the green rock cut the gneiss and fill small cracks in it. The whole has the appearance of an igneous mass, which has broken through the gneiss cracking and twisting it along the contact, and injecting itself into all the small open fractures in the same.

Contact of Huronian and Laurentian rocks.

At the lower end of the portage are green chloritic or altered hornblendic rocks, highly schistose in structure, with light quartoze veins generally running parallel to the bedding, but seen in places to cut from one plane to another. Strike N. 10° W.

The next exposure on the river is three-quarters of a mile below, where the rock is composed of dark green altered hornblende, and a dark triclinic felspar, the whole resembling an altered diorite. Thirty chains farther down stream exposures of grey Laurentian hornblende orthoclase gneiss occur. A quarter of a mile beyond is a pink hornblende orthoclase gneiss. A fine grained pink syenitic gneiss, enclosing lenticular masses of dark hornblende was seen three-quarters of a mile below the last exposure. Strike N. 20° W.

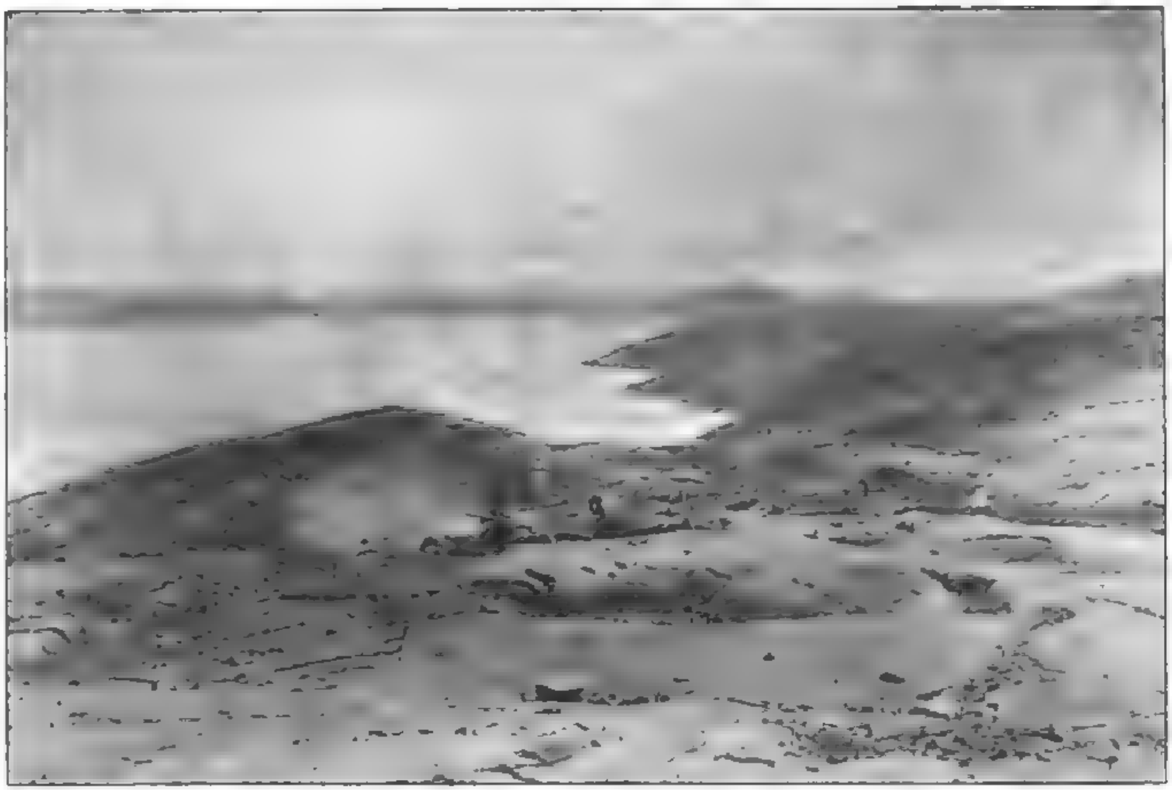
At the portage, past the eight feet fall, the rock is a greyish-pink hornblende orthoclase gneiss, highly contorted, with lenticular enclosures of hornblende.

For one mile along the upper part of the south side of the straight stretch below the fall mentioned above, the rock is composed of grey felspar, and light green felspar. This rock breaks into slabs about two feet thick, and dips S. 5° E. < 65°.

Enclosures in the gneiss.

Half a mile below the last exposures is a highly contorted pink hornblende orthoclase gneiss, containing large quantities of fragmented hornblende schist bands enclosed. Strike S. 35° W.

At the fifteen feet chute the rock is similar to the last, and from here to the mouth of the river all the exposures examined were made up of red and grey hornblende orthoclase gneiss, the red predominating.



A. P. LOW, PHOTO., 1888. THE DOMINION ILLUSTRATED PRINT, MONTREAL.

South shore of Richmond Gulf Lake, N. Lat 56° 10′, W. Long. 77° 12′, looking East, from hill 450 feet above sea level.

Almost everywhere are enclosures of a greater or less number of lenticular masses of hornblende schist, with bands of the same sometimes highly shattered. The strike ranges from S. 30° W. to S. 80° W.

Route from Richmond Gulf to Clearwater Lake.

In latitude 56° 12′ 30″ a break in the sloping rocks of the Manitounuck group, described by Dr. R. Bell in Report of Progress, 1877-78, affords an outlet to a large salt water lake. This outlet, called Richmond or Hazard Gulf, is two miles long, and not over four hundred yards wide in its most contracted part. With the change of tide the water rushes in and out through it with great velocity, forming large whirlpools, a source of great danger in the navigation of the channel with small craft. The sides of the channel are very steep and rise from the seashore to over one thousand feet on the inner side. Richmond Gulf

The Gulf Lake or Artiwinipec, often erroneously called Richmond Gulf, has the form of an isosceles triangle. The base on the south is nineteen miles long, while the perpendicular from it to the northern apex is twenty-three miles. It is surrounded by high hills. On the west, sharp cliffs, formed by the broken faces of the Manitonieck rocks, which dip towards the sea, rise in places twelve hundred feet above the water. The south and east sides are bounded by lower rounded hills of Laurentian and Huronian rocks in part flanked by beds of limestone, sandstone and trap. These hills vary from four to eight hundred feet in elevation. The surface of the lake is broken by a number of high rocky islands, three of which are of considerable extent. Small black spruce trees grow along the base of the hills, in the low valleys between them and on many of the islands. Everywhere else the rocky surface is partly covered only with a low arctic flora. Gulf Lake.

On the higher parts of the hills numerous patches of snow were seen at the end of August.

The water of the lake is deep and clear, and probably abounds with fish, judging from the presence of large numbers of seals and gulls which feed upon them. In a small lake, which lies in a depression of the hills between the Gulf Lake and the coast and empties into the lake, the Esquimaux catch large quantities of a small species of salmon which never exceed ten pounds in weight. The rise of tide in the east bay is about twenty inches.

At the head of the east bay, directly opposite to the outlet of the lake, is a small stream called Wi-ach-ti-wan River. Wi-ach-ti-wan River.

Two miles from its mouth, on the north side of the bay, is the entrance of the Clearwater River, which descends with many rapids

Route to Clearwater Lake.

and falls, through a gorge in the Laurentian Hills. Owing to the difficulty in passing these, the route to Clearwater Lake ascends the smaller stream a short distance and then passes overland to that river, reaching it a point beyond the highly obstructed part. The Wiachtiwan River, one mile from its mouth, has a sheer fall of three hundred and fifteen feet. To pass this, a portage two miles and twenty-five chains long is made over the hill on the north side. The highest point on the portage is five hundred feet above the sea level. One mile beyond, a fall of fifty-five feet causes a second portage of seventeen chains.

Portages and fall.

Above this the river averages forty yards in breadth, and winds through a valley half a mile wide between rounded gneiss hills which rise from three to five hundred above it.

The river was followed eleven miles and a-half in a general course of S. 80° E. Here a portage of one mile, fifteen chains, follows a small tributary stream to the north up from the valley to a small lake on the table-land above. The difference in elevation between the ends of the portage is three hundred and fifty feet.

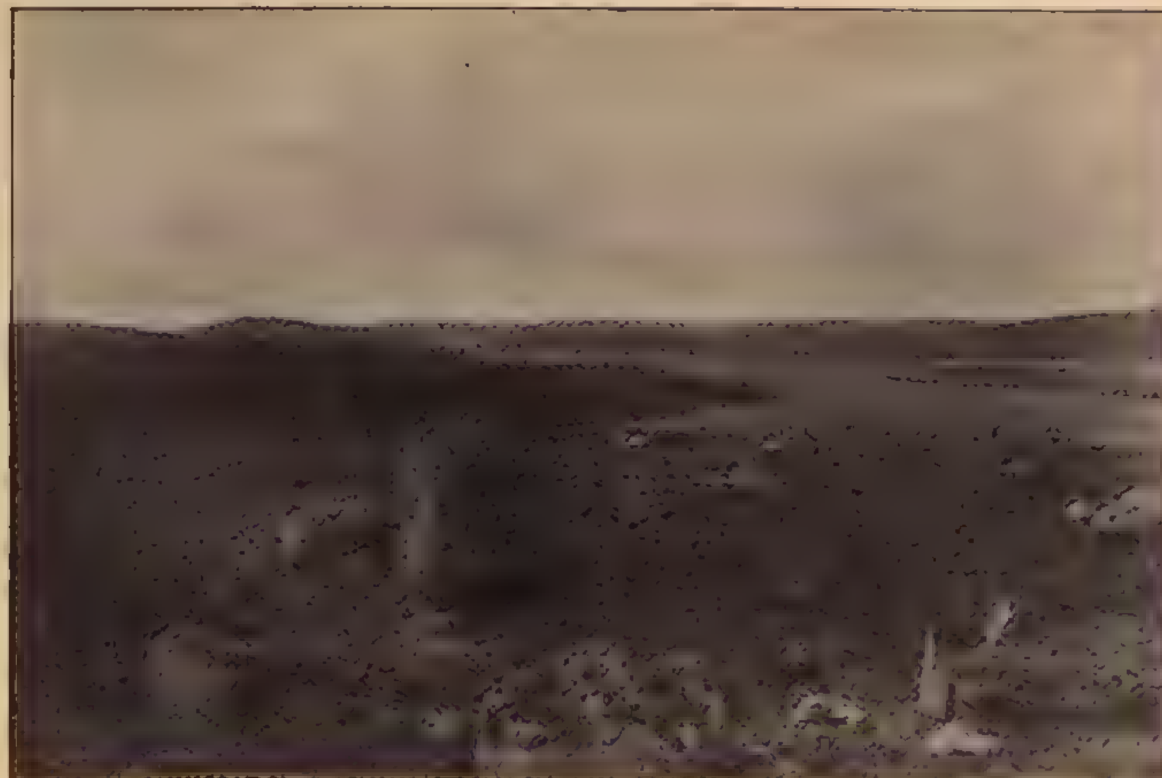
This stream flows from the east two miles and three-quarters through five small lakes connected by five small rapids, past which small portages are made, to a height of land portage of forty-eight chains that ends in a lake drained by another tributary flowing into the Wiachtiwan River farther to the eastward.

The route passes down this lake two miles to its outlet, where a portage of eight chains is made past a small rapid to another lake one mile and a-half long, followed by a portage of thirty-five chains to a large lake seven miles long, the course from the height of land portage being directly east.

Four portages of four, ten, seventeen and twenty-three chains connecting lake traverses of twenty-eight, eighty and eighty chains lead, in a north direction, to a large lake which drains in the Clearwater River. This lake is five miles and a-half long from east to west, with an average breadth of half a mile; it is broken by a number of deep, narrow bays at either end, parallel to the general course of the lake.

The route crosses from the head of the most northward bay at the east end by a portage of twenty-eight chains over a low hill into the small stream which empties it. This stream was descended in a north-west direction two miles and a-half, and there left on the north side by a portage of twenty-four chains, up a steep hill to a small lake half a mile long, from which a portage of five chains was made to Clearwater River.

A quarter of a mile up the river, an island one mile and a-half long divides it into two channels, the north channel was ascended past three



A. P. Low Photo, 1888. The Dominion Illustrated Print, Montreal.

Clearwater River, N. Lat. 56° 12', W. Long. 76° 05' looking down stream 40 miles inland from Richmond Gulf.

rapids where demi-charges were made. Above the island the river flows through a narrow valley for two miles and three-quarters, past two heavy rapids where small portages are made in ascending. From here the river widens out to half a mile, for seven miles and a-half into what is called Na-twa-ca-mi Lake, at the head of the lake is a heavy rapid passed by a portage of thirteen chains; beyond the rapid the current is sluggish for two miles and a quarter to the forks, where the two outlets of Clearwater Lake join.

Both streams are here obstructed by rapids, and the route follows up the south or smaller one one mile and a-quarter, and then crosses a portage of twelve chains from a small bay into a larger stream above the rapid.

From here the river, for one mile, is about one hundred yards wide and flows between high rocky banks to the outlet of Clearwater Lake, which is greatly obstructed by large high rocky islands.

The course from the point where the river was reached to the lake is due east.

A good view of Clearwater, or Ka-wa-cha-ga-mi Lake, was obtained from the top of an island, one mile east of the outlet, and two hundred and sixty feet above the water. The lake is surrounded by rocky hills which rise from two to four hundred feet above it. The greatest length from east to west appeared to be about thirty miles, while the average breadth was about ten miles. At its west end are a great number of high rocky islands, which continue along the south shore towards the east: about the middle of the lake many more islands appear to stretch across from shore to shore, so as to almost shut out a view of the east end. Clearwater Lake

With the exception of a few clumps of stunted black spruce trees, that grow in protected valleys, the vegetation is wholly made up of low Arctic plants, which in part cover the bare rocks.

The water of the lake is very deep and remarkably clear, the Indians catch great quantities of large lake and river trout, white fish and suckers in the lake and the river flowing out.

From the north side of Clearwater Lake a short portage route through three or four small lakes, leads to Seal Lake, out of which the Nastapoka River flows. Seal Lake

The Indians say that this is a much larger lake, surrounded by a low flat country totally barren.

From the Valley of the Wiachtiwan River to Clearwater Lake, the country traversed is a low plateau rising slowly towards the interior, and everywhere broken by roughly parallel ridges of low rounded gneiss hills, which rise from one to three hundred feet above water level; between the ridges are long narrow chains of lakes or mossy swamps.

Trees. Stunted trees of black spruce, with a few tamaracks grow on the low lands, around the margin of the lakes and in the swamps, none of these exceed thirty feet in height, nor are any over eight inches in diameter three feet from the ground.

Vegetation. The hill-tops are usually covered with a thin growth of white moss and arctic berries; on account of the absence of trees, fine views of the surrounding country may be obtained from any of the higher hills.

Terraces. Along the sides of the rocky hills, one mile up Clearwater River from Gulf Lake, five terraces were seen cut out of marine clays and sands, the highest reaching an elevation of over three hundred feet above sea level.

On the portage from the mouth of Wiachtiwan River, the road first passes up a rocky hill, partly covered with sand, and then along the top of a sandy gravel bank, fifty feet high, cut out of the stratified drift by a small stream. It then ascends an easy slope covered by coarse sand and gravel to a flat terrace fifteen chains wide and two hundred and thirty-five feet above sea level. This is covered with small bars and hummocks of coarse gravel, the remains of an old sea beach.

Ancient sea beach.

Beyond this the road again ascends an easy slope over sands and gravel to the edge of a flat plain four hundred and forty feet above the sea. Across the face of this plain, from the high hills on the north to a solitary rocky hill on the south, between the plain and the river valley, are a number of rounded knolls, in two rows. These average fifty feet in diameter and rise about five feet above the general level. They are composed of coarse gravel and small water-worn boulders, and were evidently formed in the shallow water of the old seashore line.

From here the road passes along the side of the hill on the south as the plain behind is swampy and covered with small spruce trees. At the east end of the hill is a narrow ridge of sand mixed with gravel and small boulders, one hundred feet above the river, with a sharp slope on either side. The portage follows the crest of the ridge and gradually descends from the hill towards the east to the level of the plain, where the valley of a small stream is followed to the river below. The sand and gravel of the ridge is nearly one hundred feet thick and overlies bedded clays, which form the cut banks along the small stream to the river edge. The origin of the ridge is probably due to the cutting action of the river, which at the earlier part of the period of upheaval of the land, evidently flowed to the north of the hill, and carried away about one hundred feet of sand and gravel from the top of the present plain. Later, it assumed its present course to the south of the hill, and cut away the deposits on that side leaving only the

Change in river channel.

ridge to mark the height of the old deposits. Along the valley of Wiachtiwan River, above the portage, terraces with faces cut out of stratified sand and clay are quite common, especially on the upper part. On the portage from the river valley, the first terrace is thirty feet above the river, the second, one hundred and sixty feet, and the third, a broad plain on the upper level, three hundred and ten feet, or six hundred and seventy-five feet above sea level.

The deposits out of which these are formed consist of stratified sands, with fine gravel on the top plain. Although no fossils were found in these beds, they are probably of estuarine origin and mark the amount of elevation of the land since the period of submergence subsequent to the period of glaciation.

Beyond this point, as far as Clearwater Lake, no stratified surface deposits were noted. The loose material is wholly made up of boulder till. The boulders are scattered over hill and valley in the utmost profusion. Often large rounded masses of rock of many tons weight were seen perched on the very summits of the hills and held in place by smaller boulders wedged underneath. In one place a boulder, over three feet in diameter, was seen perched upon another of twice the size. These boulders all appear to be derived from the immediate country rock and have not travelled far from their original place. The only example of a far-travelled erratic seen was a small boulder of white fossiliferous limestone, similar to that found in Hudson Straits and on the west side of Hudson Bay. This was found on the top of a hill two hundred feet above the outlet of Clearwater Lake. As the drift was here directly from the east, and as low flat land is reported by the Indians to occur about Seal Lake in that direction, it is highly probable that deposits of similar rock will be found in that neighbourhood, the boulder being carried from there by the ice.

Distribution of boulders.

At the lower end of the portage, from the mouth of the Wiachtiwan River, is a small exposure of light green felspathic argillite, belonging to the Manitounuck group of Dr. Bell (see Report of Progress 1877-78.) Along the hillside, on the upper part of the portage, a cliff of the same rocks dip N. 60° E. $< 35°$, and gives the following section in ascending order:

Manitounuck rocks.

(1.) Apple green silicious argillite, fifty feet.

(2.) Light yellowish grey sandstone, six feet.

(3.) Light grey crystalline limestone mixed with grains of quartz and shading into sandstone, with a calcite matrix, very hard and tough, thirty-five feet.

(4.) Bedded dark green amygdaloidal trap, one hundred feet.

Between this exposure and Clearwater Lake Archean gneisses only, were seen.

On the portage past the fifty-five feet fall, is a fine-grained pink micaceous gneiss, penetrated by large veins of pink orthoclase and quartz.

On the hill top, on the portage from the river valley, the rock is chiefly a dark red syenitic granite, holding small dark red garnets. Along with it are thin bands of highly contorted fine-grained pink micaceous gneiss. An immense dyke of dark green diorite, made up of moderately large crystals of dark green hornblende, and dark blue plagioclase. This dyke is over two hundred yards wide, and was seen cutting the hills on the opposite side of the river valley several miles away. Its direction is S. 35° E.

Dykes.

Another similar dyke, sixty feet wide, cuts the rocks in a N. 25° E. direction at the small lake half a mile north of the other, and may be an offshoot of the larger dyke.

On the portages between the small lakes to the height of land are exposures of pink mica-gneiss, associated with a dark-red variety, made up principally of dark-red orthoclase, with some quartz and small quantities of mica and a greenish hornblende. These rocks are often very much contorted; their general strike is S. 80° W. At the height of land portage are similar exposures, the hornblende showing signs of decomposition. Strike N. 63° W.

Gneiss.

The rocks examined along the lakes and portages of the next tributary were found to contain more hornblende, with little or no mica, and in places to enclose hornblendic segregations. General strike N. 57° W.

On crossing the height of land to the lakes draining into Clearwater River, the rocks contain larger quantities of hornblende, with more frequent hornblendic enclosures and schist bands.

On the portage from the small branch to Clearwater River are two dykes. The first one is on the hill, a short distance from the branch, it is olive-green in color, very fine-grained and compact in structure, and varies in width from five to fifty feet, with a direction of N. 70° E. The second dyke, near the Clearwater River, is coarser in texture, and composed of light-green plagioclase and dark-green hornblende; it is sixty feet wide, and runs N. 75° W. The rock cut by these dykes is a coarse-grained, pink hornblende-gneiss, containing broken bands of hornblende-schist. Strike N. 55° W.

Diorite dykes.

At the head of the island, a short distance from the portage to Clearwater River, another diorite dyke, thirty feet wide, was seen runinng N. 85° W.

All along the Clearwater River to the lake the rock exposures were found to be composed of a pink hornblende-gneiss, often granitic in structure, associated with a greater or less number of bands of dark hornblende-schist, and usually enclosing fragments or segregations of hornblende-rock. The average strike is north-west.

Glaciation and Superficial Deposits.

The hills everywhere inland to the east of Hudson Bay have been rounded off, planed and scratched by an immense glacier, which moved over the highest land, where the striæ and ice grooves upon the rock surface attest it former presence.

The following list of striæ show that the glacier moved in a uniform direction, a few degrees south of west, over all inequalities of the surface, except the deep valley of Great Whale River, where it was diverted and followed the course of the river valley.

On the Clearwater route the general direction is more nearly west than in the country to the south.

Everywhere the glacier appears to have followed the general slope of the country from the high interior gathering grounds.

Flow of great glacier.

From the evidence afforded by striæ and travelled boulders on the rivers falling into Hudson Bay from the west and south, collected by Dr. R. Bell it would appear that the continental glacier flowed down from the high land on the east side of the bay, crossed it, and had momentum and thickness sufficient to push itself in a direction south of west, up the west side over the wide margin of flat deposits of limestone, which extend inland from the present coast line some 200 miles, and then over the higher Archæan country that forms the watershed between Hudson Bay and the great lakes.

List of Glacial Sirie on the Big, Great Whale and Clearwater Rivers.

On an island in Big River seven miles above Fort George	S. 76° W.
At the chute in Big River	S. 75° W.
Seven miles above the chute	S. 80° W.
Eighteen miles above the chute	S. 70° W.
Twenty-two miles above the chute	S. 85° W.
On 1st Portage, from Big River to Bishop Roggan River (top of hill)	S. 80° W.
On 3rd Portage from Big River to Bishop Roggan River	S. 50° W.
On 5th Portage from Big River to Bishop Roggan River	S. 62° W.
Island in Piagochiwi Lake	S. 85° W.
On portage to Abpichotinachits Lake	S. 87° W.
Island in Pumigomachi Lake	S. 75° W.
Seven miles up Bishop Roggan River from Awagats Lake	S. 80° W.
Three miles above the last	S. 85° W.
Apachichuts River near the portage to Big River	S. 78° W.
Big River, at the head of the Delta	S. 75° W.
Big River, at 1st ten feet chute	S. 73° W.
Big River, at fifteen feet chute	S. 85° W.
Big River, two miles and a-half above last	S. 76° W.

Big River at thirty feet chute	S. 86° W.
On portage to Kahipikamow Lake	S. 78° W.
On portage from Kahipkiamow Lake	S. 62° W.
Portage to Masquacuiwi (top of hill)	S. 60° W.
Portage to Mishiminewaten Lake	S. 63° W.
On Mishiminewaten Lake	S. 63° W.
At Rapid to Kabimichatiwan Lake	S. 85° W.
Portage to Pospiskagami Lake	S. 62° W.
Island in Pospiskagami Lake	S. 63° W.
1st Portage on Great Whale River below Pospiskagami Lake	N. 75° W.
Half a-mile below the last	N. 60° W.
Portage two miles below the last	N. 70° W.
One mile below the last	N. 70° W.
On Portage past eight foot fall in long gorge two and a-half miles below the last	N. 82° W.
On portage at rapid at head of Indian portage route	N. 80° W. & N. 35° W.
On portage past sixty foot fall	N. 70° W.
At Forks	N. 68° W.
On hill top, on two mile portage past canon	N. 77° W.
On lower end of two mile portage past canon	N. 68° W. & N. 50° W.
On last portage Great Whale River	N. 65° W.
At foot of portage from Gulf Lake up Wiachtiwan River.	S. 83° W.
On dyke at top of hill, on portage from Wiachitiwan River	N. 70° W.
On portage from 3rd lake above the last	W.
On the long lake of 2nd tributary	S. 85° W.
At lower end of same lake	S. 80° W.
On height of land portage to Clearwater branch	S. 85° W.
On last portage to Clearwater River	S. 77° W.
At portage past upper rapid on large island in the Clearwater River	W.
At island in Natwagami Lake	S. 85° W.
On hill two miles below the outlet of Clearwater Lake	S. 78° W.
On top of island in Clearwater Lake 260 feet above the lake	S. 78° W.

Terminal moraine

During some long period between the time of extreme glaciation and the close of the period of ice, the glacier did not extend beyond the middle of James Bay, and there, in a terminal moraine, deposited great quantities of sand, clay and boulders, part of which form the present unstratified drift islands, before described in detail in this report.

Terraces.

The evidence of stratified deposits of marine sands and clays along the valleys, near the mouths of the rivers on the east side of Hudson Bay, shows that a subsidence of the land of over five hundred feet (and probably nearly seven hundred feet) took place after the period of glaciation; since then the land has been slowly rising, with periods of quiet, as shown by the terraces cut out of the drift along the high land of the coast.

APPENDIX I.

List of plants collected on the Rupert and Moose rivers, along the shores of James' Bay, and on the islands in James' Bay, during the summers of 1885 and 1887, by J. M. Macoun.

The first column in the following list contains those species found growing along the Moose River, the second those growing along the Rupert River, and the third column those growing along the shores and on the islands of James' Bay:—

	Moose River.	Rupert River.	James' Bay.
RANUNCULACEÆ.			
Anemone parviflora, Michx	*	*	*
" dichotoma, Linn	*	*	*
Thalictrum dioicum, Linn	*	*	
Ranunculus aquatilis, Linn., *var.* trichophyllus, Chaix	*	*	
" Cymbalaria, Pursh			*
" affinis, R. Br., *var.* validus, Gr			*
" abortivus, Linn	*	*	*
" Pennsylvanicus, Linn	*		
" recurvatus, Poir	*	*	
Caltha palustris, Linn		*	*
Coptis trifolia, Salisb	*	*	
Actæa spicata, Linn., *var.* rubra, Ait	*	*	
NYMPHÆACEÆ.			
Nymphæa odorata, Ait, *var.* minor, Sims	*		
Nuphar advena, Ait	*	*	
" rubrodiscum, Morong	*		
FUMARIACEÆ.			
Corydalis glauca, Pursh	*		
" aurea, Willd	*		
CRUCIFERÆ.			
Nasturtium palustre, DC	*	*	*
Cardamine hirsuta, Linn	*	*	*
" pratensis, Linn	*	*	*
Arabis humifusa, Wat., *var.* pubescens, Wat			*
" hirsuta, Scop	*		
" confinis, Watson	*		
" perfoliata, Lam	*		

	Moose River.	Rupert River.	James Bay.
Erysimum cheiranthoides, Linn.	*		*
Sisymbrium humile, C. A. Meyer.			
Draba incana, Linn., var. confusa, Poir			*
" aurea, Vahl.			
VIOLACEÆ.			
Viola blanda, Willd.	*	*	
" cucullata, Ait.	*	*	
" canina, Linn., var. Muhlenbergii, Gray	*	*	
" Canadensis, Linn.	*		
POLYGALACEÆ.			
Polygala paucíflora, Willd.	*		
CARYOPHYLLACEÆ.			
Silene acaulis, Linn.			*
Arenaria verna, Linn., var. hirta, Wat.			*
" Michauxii, Hook		*	*
" peploides, Linn.			*
Stellaria longifolia, Muhl.	*		
" borealis, Bigel. var. alpestris, Gray		*	
" longipes, Goldie	*	*	
" " var. Edwardsii, T. & G.			
" humifusa, Rottb.		*	
Cerastium arvense, Linn.	*	*	
" alpinum, Linn.			*
LINACEÆ.			
Linum perenne, Linn.			
GERANIACEÆ.			
Geranium Carolinianum, Linn.	*	*	
Impatiens fulva, Nutt.	*		
RHAMNACEÆ.			
Rhamnus alnifolia, L'Her.	*	*	
SAPINDACEÆ.			
Acer spicatum, Lam.	*	*	
LEGUMINOSÆ.			
Astragalus alpinus, Linn.			*
Hedysarum boreale, Nutt.	*		
Vicia Americana, Muhl.	*	*	
Lathyrus maritimus, Bigel.			*
" palustris, Linn.	*	*	
" ochroleucus, Hook	*		

	Moose River.	Rupert River.	James' Bay.
ROSACEÆ.			
Prunus Pennsylvanica, Linn	*	*	
" Virginiana, Linn	*		
Spiræa salicifolia, Linn	*	*	
Neillia opulifolia, Benth. & Hook	*		
Rubus Chamæmorus, Linn	*	*	*
" arcticus, Linn	*	*	*
" " *var.* grandiflorus, Ledeb		*	*
" triflorus, Rich	*	*	*
" strigosus, Mx	*	*	*
Dryas octopetala, Linn., *var.* integrifolia, Cham. & Sch			*
Geum macrophyllum, Willd	*	*	
" strictum, Ait	*	*	
" rivale, Linn	*	*	
Sibbaldia procumbens, Linn			*
Fragaria Virginiana, Duchesne	*	*	*
" vesca, Linn	*		
Potentilla Norvegica, Linn	*	*	*
" Pennsylvanica, Linn		*	*
" maculata, Pour			*
" emarginata, Pursh			*
" palustris, Scop	*	*	*
" fruticosa, Linn	*	*	*
" Anserina, Linn	*	*	*
" arguta, Pursh	*	*	
" tridentata, Solander	*	*	*
Rosa Sayi, Watson	*	*	*
Pirus Americana, DC	*	*	
Amelanchier Canadensis, T. & G., *var.* oblongifolia, T. & G	*	*	
" *var.* oligocarpa, T. & G.	*		
SAXIFRAGACEÆ.			
Saxifraga tricuspidata, Retz			*
" aizoides, Linn			*
" Hirculus, Linn			*
Mitella nuda, Linn	*	*	*
Parnassia palustris, Linn	*	*	*
" Kotzebuei, Cham. & Schlecht			*
Ribes oxycanthoides, Linn	*	*	*
" lacustre, Poir	*	*	*
" rubrum, Linn	*	*	*
" prostratum, L'Her	*	*	*
DROSERACEÆ.			
Drosera rotundifolia, Linn	*	*	
" intermedia, Drev. & Hayne, *var.* Americana, DC.	*	*	
HALORAGEÆ.			
Hippuris vulgaris, Linn	*	*	*
ONAGRACEÆ.			
Epilobium angustifolium, Linn	*	*	*
" latifolium, Linn			*

	Moose River.	Rupert River.	James' Bay.
Epilobium tetragonum, Linn	*	*	
" palustre, Linn., *var.* lineare, Gray	*	*	
Œnothera biennis, Linn	*		
Circæa alpina, Linn	*	*	
UMBELLIFERÆ.			
Sanicula Marilandica, Linn	*	*	
Cicuta maculata, Linn	*	*	
" bulbifera, Linn	*	*	
Sium cicutæfolium, Gmelin	*	*	
Archangelica atropurpurea, Hoffm			*
Heracleum lanatum, Mx	*	*	*
ARALIACEÆ.			
Aralia hispida, Vent		*	
" nudicaulis, Linn	*	*	
CORNACEÆ.			
Cornus Canadensis, Linn	*	*	*
" sericea, Linn		*	
" stolonifera, Mx	*	*	*
CAPRIFOLIACEÆ.			
Sambucus racemosa, Linn	*	*	
Viburnum pauciflorum, Pylaie	*	*	*
Linnæa borealis, Gronov	*	*	*
Lonicera cœrulea, Linn	*	*	
" involucrata, Banks	*	*	*
Diervilla trifida, Mœnch	*	*	*
RUBIACEÆ.			
Galium asprellum, Mx	*	*	
" trifidum, Linn	*	*	*
" triflorum, Mx	*	*	
" boreale, Linn	*	*	*
COMPOSITÆ.			
Eupatorium purpureum, Linn	*	*	
Solidago lanceolata, Linn	*	*	*
" Canadensis, Linn	*	*	*
" bicolor, Linn., *var.* concolor, T. & G	*	*	
" uliginosa, Nutt	*	*	
" macrophylla, Pursh	*	*	
" humilis, Pursh			*
Aster Lindleyanus, T. & G	*	*	
" puniceus, Linn		*	
" salicifolius, Ait			*
" umbellatus, Mill., *var.*	*	*	
" nemoralis, Ait		*	
" macrophyllus, Linn	*		
" lævis, Linn	*	*	

	Moose River.	Rupert River.	James' Bay.
Erigeron hyssopifolius, Mx	*	*	*
" Canadensis, Linn	*	*	
" Philadelphicus, Linn	*	*	*
" uniflorus, Linn			*
" acris, L., *var.* Droebachensis, Blytt	*		*
Antennaria plantaginifolia, Hook	*	*	
" dioica, Gærten			*
" Carpathica, R. Br			*
Anaphalis margaritacea, Benth. & Hook	*	*	
Bidens frondosa, Linn	*	*	
" cernua, Linn	*	*	*
Achillea Millefolium, Linn	*	*	*
Chrysanthemum arcticum, Linn			*
Matricaria inodora, L., *var.* nana, Hook			*
Tanacetum Huronense, Nutt			*
Artemisia borealis, Pall			*
" Canadensis, Mx			*
Petasites palmata, Gray	*	*	*
" sagittata, Gray			*
Senecio aureus, Linn			*
" " *var.* obovatus, T. & G		*	
" " *var.* Balsamitae, T. & G	*		
" Pseudo-Arnica, Less			*
Cnicus muticus, Pursh	*	*	
Hieracium umbellatum, Linn	*	*	
" scabrum, Mx	*	*	
Taraxacum officinale, Web., *var.* lividum, Koch		*	
" " *var.* alpinum, Koch			*
Lactuca leucophæa, Gray	*	*	
Prenanthes alba, Linn	*	*	
" racemosa, Mx	*	*	
LOBELIACEÆ			
Lobelia Dortmanna, Linn	*	*	
" Kalmii, Linn		*	*
CAMPANULACEÆ.			
Campanula rotundifolia, Linn		*	*
" " *var.* arctica, Lange			*
VACCINIACEÆ.			
Vaccinium Canadense, Kalm	*	*	
" Pennsylvanicum, Lam	*	*	
" uliginosum, Linn		*	*
" Oxycoccus, Linn	*	*	
" macrocarpum, Ait	*	*	*
Chiogenes hispidula, Torr. & Gray	*	*	
ERICACEÆ.			
Arctostaphylos alpina, Spreng			*
" Uva-ursi, Spreng	*	*	
Cassandra calyculata, Don	*	*	
Epigæa repens, Linn	*	*	

	Moose River.	Rupert River.	James' Bay.
Andromeda polifolia, Linn	*	*	*
Kalmia augustifolia, Linn	*	*	*
" glauca, Ait	*	*	*
Ledum latifolium, Ait	*	*	
Pyrola minor, Linn	*		
" secunda, Linn	*	*	*
" rotundifolia, Linn., *var.* asarifolia, Hook	*	*	*
" " *var.* pumila, Hook			*
Moneses uniflora, Gray	*	*	
Chimaphila umbellata, Nutt	*		
Monotropa uniflora, Linn	*		
PLUMBAGINACEÆ.			
Armeria vulgaris, Willd			*
PRIMULACEÆ.			
Primula Mistassinica, Mx	*	*	*
" farinosa, Linn	*	*	*
Trientalis Americana, Pursh	*	*	
Steironema ciliatum, Raf	*		
Lysimachia stricta, Ait	*	*	
" thyrsiflora, Linn	*		
OLEACEÆ.			
Fraxinus sambucifolia, Lam	*		
APOCYNACEÆ.			
Apocynum androsæmifolium, Linn	*	*	
GENTIANACEÆ.			
Gentiana serrata, Gunner	*	*	*
" Amarella, Linn., *var.* acuta, Hook., f	*	*	*
Pleurogyne rotata, Griseb			*
Halenia deflexa, Griseb	*		
Menyanthes trifoliata, Linn	*	*	
BORRAGINACEÆ.			
Mertensia maritima, Don			*
" paniculata, Don	*		
SCROPHULARIACEÆ.			
Mimulus ringens, Linn	*	*	
Veronica Americana, Schwein	*	*	
" scutellata, Linn	*	*	
" alpina, Linn			*
" peregrina, Linn	*		*
Castilleia pallida, Kunth, *var.* septentrionalis, Gray			*
Euphrasia officinalis, Linn	*	*	
Bartsia alpina, Linn			*
Pedicularis Grœnlandica, Retz			*

	Moose River.	Rupert River.	James' Bay.
Pedicularis Lapponica, Linn.			*
" palustris, Linn., var. Wlassoviana, Bunge		*	*
" Canadensis, Linn	*		
" flammea, Linn			*
" hirsuta, Linn			*
Rhinanthus Crista-galli, Linn	*	*	*
Melampyrum Americanum, Mx	*	*	*
LENTIBULARIACEÆ.			
Utricularia vulgaris, Linn	*	*	
" intermedia, Hayne	*	*	
Pinguicola vulgaris, Linn	*	*	*
LABIATÆ.			
Mentha Canadensis, Linn	*	*	*
" " var. glabrata, Benth			*
Lycopus sinuatus, Ell	*	*	*
Dracocephalum parviflorum, Nutt	*	*	
Scutellaria lateriflora, Linn	*	*	*
" galericulata, Linn	*	*	*
Brunella vulgaris, Linn	*	*	
Stachys palustris, Linn	*	*	*
PLANTAGINACEÆ.			
Plantago major, Linn	*	*	*
" eriopoda, Torr			*
CHENOPODIACEÆ.			
Chenopodium capitatum, Benth & Hook	*	*	
POLYGONACEÆ.			
Polygonum amphibium, Linn	*	*	
" lapathifolium, Ait, var. incanum, Koch	*	*	
" viviparum, Linn	*	*	*
" cilinode, Mx	*	*	*
Rumex salicifolius, Weinm	*		
" verticillatus, Linn			*
ELÆAGNACEÆ.			
Elæagnus argentea, Pursh	*		*
Shepherdia Canadensis, Nutt	*		
SANTALACEÆ.			
Comandra livida, Richardson	*	*	
" umbellata, Nutt	*		
URTICACEÆ.			
Urtica gracilis, Ait	*	*	

	Moose River.	Rupert River.	James' Bay.
Myricaceæ.			
Myrica Gale, Linn	*	*	*
Cupuliferæ.			
Betula lenta, Linn	*		
" lutea, Mx., f	*	*	
" papyrifera, Mx	*	*	*
" pumila, Linn	*	*	*
" glandulosa, Mx	*	*	*
Alnus incana, Willd	*	*	
" viridis, DC	*	*	*
Salicaceæ.			
Salix candida, Willd	*	*	
" desertorum, Rich	*	*	
" myrtilloides, Linn	*	*	
" glauca, Linn			
" discolor, Muhl	*	*	*
" arctica, R. Br			*
" cordata, Muhl	*		
" herbacea, Linn			
" lucida, Willd	*		
" rostrata, Rich	*		
" reticulata, Linn			*
" lanata, Linn., *var.* Macouniana, Bebb			*
Populus tremuloides, Mx	*	*	*
" balsamifera, Linn	*	*	*
Empetraceæ.			
Empetrum nigrum, Linn			*
Coniferæ.			
Juniperus communis, Linn., *var.* alpina, Gaud	*		
" Sabina, Linn., *var.* procumbens, Pursh	*		
Pinus Banksiana, Lambert	*	*	*
Picea nigra, Link	*	*	*
" alba, Link	*	*	*
Abies balsamea, Miller	*	*	*
Larix Americana, Mx	*	*	*
Hydrocharidaceæ.			
Elodea Canadense, Planchon			
Orchidaceæ.			
Liparis Loeselii, Rich	*		
Calypso borealis, Salisb	*	*	
Microstylis ophioglossoides, Nutt	*		
Corallorhiza innata, R. Br	*	*	
Listera cordata, R. Br	*	*	
" convallarioides, Nutt	*	*	
Spiranthes Romanzoviana, Chamisso	*	*	

	Moose River.	Rupert River.	James' Bay.
Goodyera repens, R. Br.	*	*	
Calopogon pulchellus, R. Br.	*		
Pogonia ophioglossoides, Ker.	*		
Orchis rotundifolia, Gray	*	*	*
Habenaria dilatata, Gray	*	*	
" hyperborea, R. Br.	*	*	*
" obtusata, Rich	*	*	*
" Hookeri, T. & G.	*		
Cypripedium acaule, Ait.	*	*	
" pubescens, Swartz	*	*	
IRIDACEÆ.			
Iris versicolor, Linn.		*	
Sisyrinchium mucronatum, Mx.	*	*	
LILIACEÆ.			
Streptopus amplexifolius, DC.	*	*	
" roseus, Mx.	*	*	
Smilacina stellata, Desf.	*	*	*
" racemosa, Desf.	*		
" trifolia, Desf.	*	*	
Maianthemum Canadense, Desf.	*	*	*
Allium Schœnoprasum, Linn.	*	*	*
Lilium Philadelphicum, Linn.	*		
Tofieldia borealis, Wahlenb.	*	*	*
" glutinosa, Willd.	*	*	
Clintonia borealis, Raf.	*	*	
JUNCACEÆ.			
Juncus filiformis, Linn.	*	*	*
" effusus, Linn.	*		*
" Balticus Dethard, var. littoralis, Engelm.	*	*	*
" triglumis, Linn.			*
" tenuis, Willd.	*	*	*
" bufonius, Linn.	*		
" alpinus, Villars, var. insignis, Fries	*	*	
" nodosus, Linn.	*		
" Canadensis, J. Gray, var. coarctatus, Engelm.	*	*	
Luzula spadicea, DC.	*	*	
" spicata, Desv.			*
" comosa, Meyer			*
" arcuata, Meyer			*
Typha latifolia, Linn.	*	*	
Sparganium simplex, Huds.	*		
" affine, Schnitzlein		*	
" hyperboreum, Laest, var. Americanum, Beeby.			*
AROIDEÆ.			
Calla palustris, Linn.	*	*	
Acorus Calamus, Linn.	*		
ALISMACEÆ.			
Alisma Plantago, Linn., var. Americanum, Gray	*		
Sagittaria variabilis, Engelm., var.	*	*	

	Moose River.	Rupert River.	James' Bay.
NAIADACEÆ.			
Triglochin maritimum, Linn.			*
" " *var.* elatum, Gray	*	*	
Potamogeton natans, Linn.	*		
" rufescens, Schrader		*	
" amplifolius, Tuck.	*		
" gramineus, Linn., *var.* graminifolius, Fries.		*	
" " *var.* heterophyllus, Fries.	*	*	
" praelongus, Wulfen	*		
" perfoliatus, Linn.	*	*	
" zosterifolius, Schum.	*		
" pauciflorus, Pursh	*	*	
" pusillus, Linn.	*	*	
" rutilans, Wolfgang			*
" marinus, Linn.		*	
" pectinatus, Linn.	*	*	*
" Robbinsii, Oakes	*		
Naias flexilis, Rostk. & Schmidt		*	
ERIOCAULONACEÆ.			
Eriocaulon septangulare, With.	*		
CYPERACEÆ.			
Eleocharis palustris, R. Br.	*		*
" tenuis, Schultes	*		
" acicularis, R. Br.	*		
Scirpus caespitosus, Linn.			*
" sylvaticus, Linn., *var.* digynus, Boeckl	*		*
Eriophorum cyperinum, Linn.	*		*
" alpinum, Linn.		*	*
" vaginatum, Linn.		*	
" capitatum, Host			*
" polystachyon, Linn.	*		
Carex nardina, Fries			*
" pauciflora, Lightf.	*		
" microglochin, Wahl.			*
" polytrichoides, Muhl.	*	*	
" teretiuscula, Good.	*	*	
" stipata, Muhl.	*		
" chordorhiza, Ehrh.		*	
" tenella, Schk.	*		
" canescens, Linn.	*	*	
" " *var.* vulgaris, Bailey		*	
" echinata, Murray, *var.* microstachys Boeck.		*	
" scoparia, Schk.	*	*	
" straminea, Schk.	*		
" Buxbaumii, Wahl.	*	*	
" atrata, Linn.		*	
" alpina, Swartz			*
" aurea, Nutt.	*	*	
" Œderi, Retz	*	*	
" flava, Linn.	*	*	
" aquatilis, Wahl.		*	*
" lenticularis, Mx.	*	*	

	Moose River.	Rupert River.	James' Bay.
" maritima, Muller			*
" Magellanica, Lamarck	*	*	
" rariflora, Smith			*
" limosa, Linn	*	*	
" vaginata, Tausch	*	*	
" concinna. R. Br.		*	
" arctata, Boott, *var.* Faxoni, Bailey		*	
" flexilis, Rudge	*	*	
" capillaris, Linn	*	*	*
" riparia, W. Curtis			*
" filiformis, Linn	*		
" lanuginosa, Mx	*	*	
" Michauxiana, Bœckl		*	
" oligosperma, Mx		*	
" miliaris, Mx		*	
" saxatilis, Linn			*
" rotundata, Wahl			*
" rostrata, With			*
" " *var.* reticulata, Bailey	*	*	
" monile, Tuck	*	*	
" retrorsa Schw	*		
GRAMINEÆ.			
Beckmania erucæformis, Host, *var.* uniflorus, Scrib		*	*
Panicum dichotomum, Linn		*	
Hierochloa alpina, Rœm. & Schultz			*
" borealis, Rœm. & Schultz	*	*	*
Alopecurus alpinus, Smith			*
" geniculatus, Linn., *var.* aristulatus, Munro		*	
Stipa Richardsonii, Link		*	
Oryzopsis asperifolia, Mx	*	*	
Muhlenbergia glomerata, Trin	*		
Phleum alpinum, Linn			*
Agrostis scabra, Willd	*	*	*
Cinna pendula, Trin	*	*	
Deyeuxia Canadensis, Hooker	*	*	*
" Langsdorffii, Kunth			*
" neglecta, Kunth		*	*
" borealis, Macoun			*
Deschampsia atropurpurea, Scheele		*	
" " *var.* minor, Vasey			*
" cæspitosa, Beauv	*	*	
" " *var.* maritima, Vasey			*
" alba, Rœm. & Schultz	*	*	
Trisetum subspicatum, Beauv. *var.* molle, Gray			*
Eatonia Pennsylvanica, Gray	*		
Catabrosa aquatica, Beauv	*	*	*
Poa alpina, Linn			*
" cæsia, Smith	*		
" cenisia, Ait.			*
" pratensis, Linn	*	*	
Glyceria arundinacea, Kunth			*
" Canadensis, Trin	*	*	
" fluitans. R. Br	*		
" maritima, Wahl			*
" nervata, Trin	*	*	
Festuca ovina, Linn., *var.* brevifolia, Watson			*

	Moose River.	Rupert River.	James' Bay.
Bromus ciliatus, Linn	*	*	*
Agropyrum tenerum, Vasey		*	
Hordeum jubatum, Linn		*	*
Elymus mollis, Trin			*
EQUISETACEÆ.			
Equisetum arvense, Linn	*	*	
" palustre, Linn	*	*	
" scirpoides, Mx	*	*	
FILICES.			
Polypodium vulgare, Linn	*	*	
Pellæa gracilis, Hook		*	
Pteris aquilina, Linn	*	*	
Asplenium viride, Hudson	*	*	
" Filix-fœmina, Bernh	*	*	
Phegopteris Dryopteris, Feé	*	*	
" calcarea, R. Br		*	
Aspidium spinulosum var. dilatatum, Gray	*	*	*
Onoclea sensibilis, Linn	*	*	
Cystopteris fragilis, Bernh	*	*	
" montana, Bernh		*	
Woodsia Ilvensis, R. Br	*	*	
" glabella, R. Br	*	*	
Osmunda regalis, Linn	*	*	
" Claytoniana, Linn	*	*	
Botrychium Lunaria, Swartz	*	*	*
" Virginicum, Swartz	*	*	
" ternatum Swartz, var. lunarioides, Willd		*	*
LYCOPODIACEÆ.			
Lycopodium annotinum, Linn	*	*	*
" dendroideum, Mx	*	*	*
" clavatum, Linn	*	*	*
" complanatum, Linn	*	*	*
" sabinaefolium, Willd		*	

APPENDIX II.

LIST OF DIURNAL LEPIDOPTERA AND COLEOPTERA

Collected by Mr. J. S. COTTER at Moose Factory in 1888, and by Mr. J. M. MACOUN on the south coast and islands of James Bay in 1887. Determined by Mr. JAS. FLETCHER, Dominion Entomologist.

DIURNAL LEPIDOPTERA TAKEN AT MOOSE FACTORY.

Papilo Turnus, L. (8 specimens.) 16 June–16 July.
Pieris Napi, Esp., winter form *Oleracea-hiemalis*, Har. (12 specimens.) 11–18 June.
Pieris Rapæ, L. (2 specimens.) 17–24 August.
Colias Scudderii, Reak. 17 August.
Colias Nastes, Bd. No particulars.
Argynnis Polaris, Bd. 18 June.
Phyciodes Tharos, Dru. winter form *Marcia*, Edw. 31 August.
Grapta Progne, Cram. 18 June.
Vanessa Antiopa, L. (2 specimens.) 11 June.
Vanessa Milberti, God't. (3 specimens.) 18–20 June.
Pyrameis Atalanta, L. (17 specimens.) 6–19 June.
Limenitis Arthemis, Dru., var. *Lamina*, Fab.
Cœnonympha Inornata, Edw. (3 specimens.) 31 August.
Lycæna Pseudargiolus, Bl., winter form *Lucia*, Kirby. (3 specimens.) 25 June.

COLEOPTERA TAKEN ON THE SOUTH COAST AND ISLANDS OF JAMES BAY.

Cicindela 12-guttata, Dejean.
Calosoma frigidum, Kirby.
Chlænius sericeus, Forster.
Silpha Lapponica, Illist.
Dicerca divaricata, Say.
Buprestis maculiventris, Say.
Asemum mæstum, Haldeman.
Criocephalus obsoletus, Randall.
Xylotrechus undulatus, Say.
Rhagium lineatum, Olivier.
Pachyta liturata, Kirby.
Acmæops proteus, Kirby.
Leptura chrysocoma, Kirby.
Monohammus scutellatus, Say.
Orsodachna atra, Ahr.
Adoxus vitis, L.
Lina Lapponica, L.
Lina scripta, Fabricius.
Gonioctena pallida, L.
Upis ceramboides, L.
Lepyrus colon, L

APPENDIX III.

Notes on the Breeding Habits of certain Mammals, from Personal Observations and Enquiries from Indians

By Mr. Miles Spencer, Fort George, Hudson Bay.

Rangifer Groenlandicus, L. Barren Ground Caribou.

These animals mate about the end of October, and the calves, one or two in number, are born about 1st July. The young at birth are the size of a small calf, red and white in color, very active, with open eyes. The female suckles the young for a period of two months.

Lynx Canadensis, Geoffroy. Canada Lynx.

The season of heat occurs about 1st March, when coition takes place as in dogs. The young, one to three in number, are born in holes lined with grass and moss. At time of birth they are slightly larger than the common adult red squirrel, of a grey color, helpless, with closed eyes. They are suckled by the female for three months, the male assisting in rearing them.

Canis lupus occidentalis, Richardson. Wolf.

Coition dog-like. It takes place about the middle of March, and the young, one to five in number, are born about the middle of June, in holes or under rocks. The young, when born, are about the size of an Esquimaux or Newfoundland pup, grey in color, with closed eyes and helpless. They are suckled for two months after birth by the female, who is assisted by the male in rearing them.

Vulpes lagopus, L. White or Arctic Fox.

These animals pair about the 1st March, and the young are born about the end of June. From one to seven are produced at a litter in holes under rocks. At time of birth they are somewhat larger than a squirrel, light grey in color, helpless, with closed eyes. The female suckles the young for two months, and is assisted by the male in rearing them

Gulo luscus (L.), Sabine. Wolverine.

The wolverine mates about the middle of March, coition being dog-like. The young, one to three in number, are born about the middle of June. At birth they are about the size of an Esquimaux pup, reddish brown in color, helpless, with closed eyes. They are born in holes and under rocks, and are suckled for two months. The male assists in rearing the young.

Mustela Americana, Turton. Marten.

Coition is dog-like. It occurs about the 1st March, and the young are born, about the end of April, in holes, in rotten trees, lined with grass and moss. From one to five are produced at a birth, when they are the size of a new-born kitten, brown and black in color, helpless, with closed eyes. The female suckles the young for a period of five weeks, and is unassisted by the male in rearing them. Sometimes the female gives birth in a burrow in the ground.

Putorius vison, Brisson. Mink.

Coition dog-like. It takes place towards the end of February, and the young, one to three in number, are born about 1st May. At time of birth they are the size of a small mouse, very black in color, helpless, with eyes closed. The female makes a nest in a hole lined with grass, and suckles the young for six weeks. The male does not assist in rearing the young.

Mephitis mephitica, Shaw. Skunk.

Coition is dog-like, and takes place about 1st October. The young, one to three in number, are born in holes about 1st May. At time of birth they are the size of a large mouse, light brown in color, helpless, and eyes closed. The female suckles them for six weeks. The male does not assist in rearing the young.

Lutra Canadensis, Turton. Otter.

Coition dog-like. It takes place towards the end of February, and the young, one to three in number, are born, about 1st May, in holes, lined with grass. When born they are the size of a small squirrel, very black in color, helpless, with closed eyes. The female suckles them for six weeks, and is unassisted by the male.

Ursus Americanus, Pallas. Black Bear.

The period of heat occurs at the 1st of June, when coition takes place as in dogs. The young, one to three in number, are born at the end of October, in holes under rocks, lined with brush,

grass and moss. At the time of birth the cubs are the size of a squirrel, black in color, quite helpless, with closed eyes. They are suckled for five months, the male assists in rearing the young.

Thalassarctos maritimus, Linn. White Bear.

Coition, which is dog-like, takes place about the middle of April, and the young, from one to three in number, are born in holes under rocks lined with brush, grass, and moss, towards the end of October. At time of birth they are the size of a large rat, white in color, helpless, and with closed eyes. They are suckled for five months, the male assisting in rearing them.

Fiber zibethicus, L. Muskrat.

This animal mates about the middle of May, coition being cat-like, and the young, from one to six in number, are born about the middle of June. At time of birth they are the size of a small mouse, light brown in color, helpless, with closed eyes. The nest is built in a house or lodge, made of sticks and mud, in shallow ponds or quiet streams, and is lined with grass and moss. The female suckles the young for three weeks, and is assisted by the male in rearing them. The muskrat breeds twice subsequent to the first birth during the summer.

Erethizon dorsatus, L. Canada Porcupine.

Coition, which is cat-like, takes place about 1st October, and the young one is born unsheltered at the end of April. When born it is the size of a small rat, black in color, active, with open eyes. The female suckles it for two weeks, and is unassisted by the male in rearing it

Castor fiber, L. Beaver

At the end of February coition, which is cat-like, takes place, and the young, from one to nine in number, are born about the 1st June, in a house lined with brush and grass. They are then the size of a rat, light brown in color, helpless, with closed eyes. The female suckles the young for six weeks, and is assisted by the male in rearing them.

Arctomys monax, L. Woodchuck, Wenusk.

Coition, which is cat-like, takes place about the middle of October, and the young, from one to ten in number are born about the 1st May. At time of birth they are the size of a large mouse, yellow-

brown in color, helpless, with eyes closed. The nest is in a hole lined with grass. The female suckles the young for six weeks, and is assisted in rearing them by the male.

Delphinapterus catadon, L. White Porpoise.

Coition takes place under water. The two animals, with a noise as if they were rubbing hard against each other, rise to the water until nearly the whole body is visible, then come in sudden contact, and fall asunder. The time of mating is about the middle of June, and the young, one to two in number, are born towards the end of July, when they are from two to four feet long, of a lead color, very active, with open eyes. The female suckles them for at least three months.

APPENDIX IV.

(1) METEOROLOGICAL OBSERVATIONS ON JAMES BAY IN 1887, BY A. R. CUNNINGHAM, AND ON THE EAST COAST OF HUDSON BAY IN 1888, BY C. H. MACNUTT.

The barometer used was a small aneroid, but the readings have been corrected for instrumental error, and are believed to be nearly exact.

The Temperature is stated in degrees Fahrenheit. The force of the wind is estimated according to a scale from 0 to 10.

The proportion of the sky covered by clouds is estimated by a scale of 0 to 10, 0 being a cloudless sky, 10 a completely clouded sky. The character of the clouds is denoted by the usual letters or combination of letters referring to Howard's classification.

PLACE	Date.		Hour.	Barometer corrected.	Ther. corrected. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval.
	1887.												
Missinaibie Station	May	25	7.00 a.m.	28.46	°	°	42.	0.	0	2	K S.	Fair	Fair.
" "	"	25	2.00 p.m.	28.40				S. W.	1	5	K S.	Dull, part cloudy.	Passing showers.
" "	"	25	9.00 p.m.	28.36				S. W.	2	8	S.	Passing showers.	Passing showers.
" "	"	26	7.00 a.m.	28.28			44.	S. W.	1	10	S.	Light rain.	Light rain.
" "	"	26	2.00 p.m.	28.32				S. W.	2	10	S.	Rain and gloomy.	Light rain.
" "	"	26	9.00 p.m.	28.45				S. W.	2	10	S.	Rain.	Rain.
" "	"	27	7.00 a.m.	28.69			46	N. W.	2	2	K C.	Fair.	Clearing.
" "	"	27	2.00 p.m.	28.70				N. W.	2	0	0.	Fair	Very fair.
" "	"	27	9.00 p.m.	28.71				N. W.	1	0	0.	Very fair.	Very fair.
" "	"	28	7.00 a.m.	28.69			29.	N.	1	0	0.	Very Fair.	Very fair.
H. of L. Portage to Missinaibie River.	"	28	2.00 p.m.	28.65				N.	2	4	K S.	Fair.	Very fair.
Portage to Missinaibie Lake.	"	28	9.00 p.m.	28.62				N	1	0	0.	Very fair.	Very fair. squally.
" " "	"	29	7.00 a.m.	28.59			40.	N.	1	0	0.	Very fair.	Very fair.
Missinaibie Lake.	"	29	2.00 p.m.	28.58				S. E.	1	3	K S.	Fair.	Detached clouds.
" "	"	29	9.00 p.m.	28.54				0	0	5	S.	Gloomy.	Detached clouds.
" "	"	30	7.00 a.m.	28.58			48.	N. E.	1	2	K C.	Fair.	Fair.
Keg Portage, Missinaibie River	"	30	2.00 p.m.	28.59				N	2	10	S.	Thunder showers.	Thunder *from* 1 p.m.
Keg Portage " "	"	30	9.00 p.m.	28.63				E	1	6	K S.	Banked clouds.	Cleared at 8 p.m.
Head of Swamp " "	"	31	7.00 a.m.	28.75			47	S.	1	9	S.	Gloomy.	Light showers during night.
Island Portage " "	"	31	2.00 p.m.	28.82				S.	1	10	S.	Heavy thunder storms.	Thunder showers
Green Hill Portage " "	"	31	9.00 p.m.	28.93				0	0	10	S.	Overcast	Passing showers.
" " " "	June	1	7.00 a.m.	28.86			48.	E.	1	10	S.	Overcast.	Passing showers.
St. Peter	"	2	7.00 a.m.	28.86				N. E.	1	9	S.	Overcast.	Light showers at 4 a.m.

St. Paul.	Missinaibie River	"	2	2 00 p.m	28 82	...	...	N E	1	8	K S	Cloudy, dull.	Overcast.
"	"	"	2	9 00 p.m.	28 82			0	0	7	K S	Banked clouds	Passing showers.
Two Portage,	"	"	3	7 00 a.m	28 85		58	N E	1	8	K S	Gloomy.	Light showers at 4.30 a. m.
"	"	"	3	2.00 p.m	28 82			0	0	9	S.	Gloomy.	Passing showers.
Pond Portage.	"	"	3	9 00 p.m	28 82			0	0	0	0	Fair.	Fair.
"	"	"	4	7 00 a.m	28 89		45	0	0	1	K C	Fair.	Fair with light passing showers.
Devil's Rapids.	"	"	4	2 00 p.m	28 88			S E	2	6	K S	Light showers.	Detached clouds.
Albany Rapids.	"	"	4	9 00 p.m	28 88			0	0	5	K S	Detached clouds	Fair.
"	"	"	5	7 00 a.m	29 28		47	N E	2	4	K S	Detached clouds	Fair.
Beaver Portage,	"	"	5	2 00 p.m	29 27			N E	1	0	0	Very fair.	Very fair
"	"	"	5	9 00 p.m.	29 24			0	0	0	0	Very fair.	Very Fair
"	"	"	6	7 00 a.m	29 28		49	N W.	3	2	K C	Very fair.	Very fair
Sharp Rock Portage,	"	"	6	2 00 p.m	29 16			S. W.	1	1	C.	Very fair.	Misty
Sandy Bay Portage,	"	"	6	9 00 p.m	29 06			0	0	1	C.	Misty and smoke.	Smoke.
"	"	"	7	7 00 a.m	28 78		54	S W.	1	2	K C	Smoky.	Smoke
Crow Rapid.	"	"	7	2 00 p.m	29 01			S W.	3	9	K S	Gloomy, showers.	Passing showers.
Black Feather Rapid.	"	"	7	9 00 p.m	29 10			0	0	1	C.	Fair.	Passing showers.
"	"	"	8	7 00 a.m	29 13		57	N. W.	3	10	S.	Drizzling rain	Light rain during night.
Kettle Portage.	"	"	8	2 00 p.m	29 22	56.		N. W.	3	10	S.	Cold [illegible]	Cold rain all morning.
"	"	"	8	9 00 p.m	29 25	47		N. W.	1	10	S.	Cold showers.	Cold rain, with fog.
"	"	"	9	7 00 a.m	29.30	58	47	N.	2	0	0	Fair.	Fair.
"	"	"	9	2 00 p.m	29 28	64		N. W.	1	0	0	Very fair.	Very fair
"	"	"	9	9 00 p.m	29 32	54		0	0	0	0	Very fair.	Very fair
"	"	"	10	7 00 a.m	29 38	68	36	N W	1	0	0	Very fair.	Very fair.
"	"	"	10	2 00 p.m	29 32	73		N W.	2	0	[illegible]	Very fair.	Very fair.
"	"	"	10	9 00 p.m	29 30	50		0	0	0	0	Very fair.	Very fair.
"	"	"	11	7 00 a.m	29 32	63	44	S. E	2	0	[illegible]	Very fair.	Very fair.
"	"	"	11	2 00 p.m	29 28	81		S E	3	0	[illegible]	Very fair.	Very fair.
"	"	"	11	9 00 p.m	29 23	70.		S E	1	10	S.	Overcast	Light showers
"	"	"	12	7 00 a.m	29.12	63	57.	S.	2	10	S.	Gloomy	Overcast.
"	"	"	12	2 00 p.m	29 14	72		S.	2	3	K S.	Fair.	Light rains in morning
"	"	"	12	9 00 p.m	29 22	61		0	0	5	K S.	Passing showers	Passing showers.
"	"	"	13	7 00 a.m	29 44	52	47	N E.	3	10	S.	Gloomy, overcast.	Cloudy.
"	"	"	13	2 00 p.m	29 41	58		0	0	2	K.	Fair	Fair.
"	"	"	13	9 00 p.m	29 46	47		0	0	0	0	Very fair.	Very fair.
"	"	"	14	7 00 a.m	29 39	60	37	0	0	0	[illegible]	Very fair.	Very fair.
"	"	"	14	2 00 p.m	29 32	70		S W.	1	0	0	Very fair.	Very fair
"	"	"	14	9 00 p.m	29 22	68		0	0	5	K S.	Banked clouds.	Passing showers.
"	"	"	15	7 00 a.m.	29 13	67.	57	S W.	1	1	K.	Fair.	Fair.
"	"	"	15	2 00 p.m	29 07	85		S W.	2	2	K	Fair.	Thunder showers.
"	"	"	15	9 00 p.m	28 97	63		N W.	2	10	S.	Overcast, gloomy.	Showers.
"	"	"	16	7 00 a.m.	29 15	52	52	N E	3	10	[illegible]	Overcast.	Overcast.
"	"	"	16	2 00 p.m	29 20	62		N W	3	7	K S.	Detached clouds.	Clearing.
"	"	"	16	9 00 p.m.	29 27	63		N W.	1	0	0	Very fair.	Fair
"	"	"	17	7 00 a.m.	29 24	60	33	N E.	2	8	K S.	Fair.	Fair.
Skunk Id.	"	"	17	2 00 p.m.	29.22	70		N W	1	9	K S	Overcast.	Banked clouds.
Rapids above C. H. Portage, Missinaibie River		"	17	9 00 p.m	29.10	58.		N W.	2	0	0	Fair.	Fair.
Rapids above C. H. Portage, Missinaibie River		"	18	7 00 a.m	29 12	48	35	S E	1	8	K S	Detached clouds	Fair.

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval.
	1887.			°	°	°						
Riverside Portage, Missinaibie River	June 18	2.00 p.m.	29.05	72	....	....	S. E.	1	4	K.S.	Banked clouds.	Passing showers.
Conjuring Ho. Portage, Missinaibie River	" 18	9.00 p.m.	29.[illegible]	60	....	....	0	0	5	K.S.	Banked clouds.	Passing showers.
" "	" 19	7.30 a.m.	29.02	48	....	41	0	0	10	S.	Overcast.	Passing showers.
" "	" 19	2.00 p.m.	29.02	68	....	....	0	0	10	S.	Rain.	Light rain.
" "	" 19	9.00 p.m.	29.07	58	....	....	0	0	10	S.	Overcast	Light rain.
" "	" 20	7.00 a.m.	29.12	68	....	48	S. E.	2	2	C.	Fair.	Light showers.
Store Portage "	" 20	2.00 p.m.	29.11	77	....	....	S.	3	2	K.	Fair	Fair.
" "	" 20	9.00 p.m.	29.05	74	....	....	S. W.	1	10	S.	Overcast	Cloudy.
" "	" 21	7.00 a.m.	28.84	58	....	50	S. W.	1	10	S.	Overcast	Light rain.
" "	" 21	2.00 p.m.	28.79	[illegible]	....	....	N. W.	2	8	K.S.	Banked clouds.	Passing showers, heavy
Long Portage	" 21	9.00 p.m.	28.83	62	....	....	S. W.	1	8	K.S.	Gloomy.	Gloomy.
" "	" 22	7.00 a.m.	28.84	51	....	50	S. W.	3	10	S.	Gloomy	Rain during night.
" "	" 22	2.00 p.m.	28.92	56	....	....	N. E.	6	10	S.	Overcast.	Overcast.
" "	" 22	9.00 p.m.	28.96	55	....	....	0	0	10	S.	Overcast.	Overcast.
" "	" 23	7.00 a.m.	28.85	[illegible]	....	42	0	0	10	S.	Overcast.	Shower early in a.m.
" "	" 23	2.00 p.m.	29.02	66	....	....	0	0	10	S.	Light rain.	Showers all morning.
" "	" 23	9.00 p.m.	29.11	57	....	....	0	0	10	S.	Light showers.	Showers
" "	" 24	7.00 a.m.	29.12	50	....	45	0	0	10	S.	Gloomy.	Passing showers
Popular River,	" 24	2.00 p.m.	29.52	60	....	....	N. E.	1	10	S.	Overcast.	Light rain.
"Bubbling Water,"	" 24	9.00 p.m.	29.64	55	....	....	0	0	10	S.	Light showers.	Overcast, with light showers
" "	" 25	7.00 a.m.	29.83	[illegible]	....	50	N. W.	1	10	K.S.	Overcast.	Passing showers.
"	" 25	2.00 p.m.	29.96	61	....	....	N. E.	2	10	K.S.	Overcast	Overcast.
[illegible] m. above Mattagami River	" 25	9.00 p.m.	29.96	58	....	....	0	0	9	K.S.	Clearing.	Overcast.
" "	" 26	7.30 a.m.	30.22	58	....	54	S. E.	2	10	K.S.	Detached clouds	Clearing.
Gypsum Rapid, Moose River.	" 26	2.00 p.m.	30.18	[illegible]	....	....	0	[illegible]	1	C.	Fair.	Fair.
Forks of Abbittibi River	" 26	9.00 p.m.	30.12	57	....	....	0	0	3	K.	Fair	Fair.
" "	" 27	7.00 a.m.	30.10	[illegible]	....	[illegible]	S. E.	4	2	[illegible]	Fair	Fair.
Head of Tide, Moose River	" 27	2.00 p.m.	30.49	88	....	....	S.	6	1	K.	Fair	Fair.
Moose Factory	" 27	9.00 p.m.	30.48	72	....	....	S. E.	2	0	0	Very fair	Very fair.
"	" 28	7.00 a.m.	30.47	61	....	59	S.	1	2	K.	Fair	Fair.
"	" 28	2.00 p.m.	30.36	85	....	....	N.W.	6	3	K.	Fair	Fair.
"	" 28	9.00 p.m.	30.47	[illegible]	....	....	N.W.	1	1	K.	Very fair	Very fair.
"	" 29	7.00 a.m.	30.[illegible]	68	....	60	0	0	4	K.C.	Fair.	Fair
"	" 29	2.00 p.m.	30.19	83	....	....	S.W.	3	5	K.S.	Fair.	Fair
"	" 29	9.00 p.m.	30.2[illegible]	80	....	....	S. E.	4	5	K.S.	Fair	Fair.
"	" 30	7.00 a.m.	30.25	69	....	58	N.W.	7	5	K.S.	Fair	Fair.
"	" 30	2.00 p.m.	30.08	83	....	....	N.W.	7	2	K.S.	Very fair.	Very fair.
"	" 30	9.00 p.m.	29.98	70	....	....	S. E.	5	8	K.S.	Passing showers	Passing showers during night.

Moose Factory	July	1	7 00 a.m	29 93	71	57	S. E.	6	9	K. S.	Thunder shower.	Thunder showers
"	"	1	2 00 p.m	29 8[illegible]	80	......	N. W.	4	8	K. S	Thunder clouds	Thunder showers.
"	"	1	9 00 p.m	29 94	70	...	N. W.	6	10	S.	Rain.	Thunder showers.
"	"	2	7 00 a.m	30 04	62	56	N. W.	3	1[illegible]	S	Overcast.	Gloomy.
"	"	2	2 00 p.m	30 18	67	...	N. W.	5	9	K. S	Overcast.	Overcast.
Mouth of Moose River	"	2	9 00 p.m	30 23	62	......	N. E.	5	6	K. S	Detached clouds	Detached clouds.
" "	"	3	11 00 a.m	30 30	6[illegible]	...	E	5	5	C.	Misty.	Overcast.
Hannah Bay	"	3	8 30 p.m	30 21	5[illegible]		E	4	9	K. S	Overcast, gloomy	Overcast, gloomy
E. Coast of Hannah Bay	"	4	8 00 p.m	30 09	[illegible]		S. E.	2	10	S.	Overcast.	Gloomy, misty.
" "	"	4	3 00 p.m	30 12	71	...	N.	1	8	K. S	Gloomy, mist.	Overcast.
" "	"	5	3 00 a.m	30 15	66		N	4	5	K. S.	Fair.	Fair.
Charleton Islands	"	5	9 00 a.m	30 10	62	..	E	5	10	K. S	Overcast.	Overcast
"	"	5	1 00 p.m	30 07	73	..	E	4	10	S.	Dull gloomy.	Dull.
"	"	5	9 00 p.m	30 00	60		S. E.	2	10	S	Foggy.	Foggy.
"	"	6	7 00 a.m	29 98	60	52	S. E.	2	8	S.	Thick fog.	Thick fog.
"	"	6	2 00 p.m	29 92	72	...	S.	1	10	S	Overcast	Thunder storm.
"	"	6	9 00 p.m	29 92	62	...	N.	1	5	K. S	Fog.	Gloomy with fog.
"	"	7	7 00 a.m	29 8[illegible]	63	51	S. E.	1	10	S.	Overcast, with fog	Fog.
"	"	7	2 00 p.m	30 08	67		N.	7	1	C.	Very fair.	Fog clearing
"	"	7	9 00 p.m	30 1[illegible]	61		N.	2	10	C. S	Gloomy, fog.	Fair, with fog in evening.
"	"	8	7 00 a.m	30 18	41	40	S. E.	4	10	S.	Misty.	Clear
"	"	8	2 00 p.m	30 09	51	...	0	0	1	S.	Very fair.	Very fair
"	"	8	9 00 p.m	29 98	56		0	0	10	S	Overcast, misty	Overcast in evening.
"	"	9	7 00 a.m	29 74	58	52	E	7	10	S.	Thunder showers.	High wind with thunder storm.
"	"	9	2 00 p.m.	29 67	58	......	N. E.	8	10	S.	Heavy gale, with rain.	Heavy gale with rain.
"	"	9	9.00 p.m	29 71	55		N. E.	8	10	S	Gloomy, thunder squall.	Heavy gale with thunder storm
"	"	10	7 00 a.m	29 87	52	47	N.	4	2	C. S.	Fair.	Clearing to fair.
"	"	10	2 00 p.m	29 97	57.		W	6	0	0	Very fair.	Very fair.
"	"	10	9 00 p.m	30 01	53		N.	3	2	K	Detached clouds	Partly cloudy.
"	"	11	7 00 a.m	30.06	57	41	S. E.	4	6	K. S	Detached clouds	Partly cloudy.
Stratton Islands	"	11	2 00 p.m	30 04	58		N. W.	3	10	S.	Dull, gloomy.	Overcast
"	"	11	9 00 p.m	30 14	57		0	0	10	K. S.	Fog, gloomy.	Fog, overcast.
"	"	12	7 00 a.m	30 14	63	42	S. E.	1	9	S.	Fog and light showers.	Overcast
Little Charleton Island	"	12	2 00 p.m	30 11	65	...	N. W.	4	4	C. S.	Fog.	Fog with showers in a.m.
"	"	12	9 00 p.m	30 00	57	...	0	0	2	K. S	Fair.	Thunder storm in p.m
"	"	13	7 00 a.m	29 94	58	52.	N.	7	0	0	Very fair, gale.	Clearing, strong wind.
"	"	13	2 00 p.m	30 21	59	...	N. W.	7	2	K. S	Very fair, gale.	Fair, moderate gale.
"	"	13	9.00 p.m.	30 26	51	...	0	0	5	K. S	Misty	Misty, thunder storm.
"	"	14	7 00 a.m	30 38	56	38	N. W.	4	10	S.	Fog and mist.	Fog and wind.
"	"	14	2 00 p.m	30 42	66	......	N. E.	3	2	K. S	Fair, with thin fog.	Fog, clearing.
"	"	14	9 00 p.m	30 37	53.	......	0	0	1	S.	Fair.	Fair.
"	"	15	7 00 a.m	30 27	56	44	S. W.	2	6	K. S	Detached clouds	Cloudy.
Solomon's Temple Island	"	15	2 00 p.m	30 10	57		S.	5	4	K. S.	Fair.	Fair.
South Twin Island	"	15	9 00 p.m	29 92	50		S. E.	5	10	K. S	Overcast with fog	Cloudy, fog.
"	"	16	7 00 a.m	30 04	51	48	N.	8	10	S.	Gloomy, foggy.	Overcast and misty.
"	"	16	2 00 p.m	30 10	57	...	N. E.	8	10	S.	Misty	Misty, heavy gale

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval
	1887.											
South Twin Island	July 16	9.00 p.m.	30.24	42.			N. E.	8	10	S.	Overcast with fog.	Overcast with fog, heavy gale.
"	" 17	7.00 a.m.	30.37	42		37.	N.	6	10	S.	Overcast with fog.	Gloomy.
"	" 17	2.00 p.m.	30.34	56			N. E.	5	4	K. S.	Fair.	Clearing to fair.
"	" 17	9.00 p.m.	30.30	41.			N. W.	2	2	K. S.	Fair.	Fair.
"	" 18	7.00 a.m.	30.30	40		40	S. W.	6	1	C.	Fair.	Fair.
"	" 18	2.00 p.m.	30.30	78			S. W.	4	1	S.	Fair.	Fair.
North Twin Island	" 18	9.00 p.m.	30.18	50			S. W.	5	7	K. S.	Gloomy, overcast.	Fair.
"	" 19	7.00 a.m.	30.06	[illegible]		42	S. E.	1	8	K. S.	Overcast.	Heavy thunder storm in a.m.
"	" 19	2.00 p.m.	30.04	[illegible]			S. W.	5	10	S.	Foggy.	Rain and fog.
"	" 19	9.00 p.m.	29.97	57			S. W.	4	10	S.	Very foggy.	Thick fog.
"	" 20	7.00 a.m.	30.10	52		47	S. W.	6	10	S.	Fair.	Clearing to fair.
"	" 20	2.00 p.m.	30.15	52			N. W.	5	8	K. S.	Fair.	Fair.
Spencer Island	" 20	9.00 p.m.	30.18	47			N.	2	5	K. S.	Fair.	Fair.
"	" 21	7.00 a.m.	30.11	45		38	S. W.	3	5	K. S.	Detached clouds	Overcast.
Comb Hills, East Coast	" 21	2.00 p.m.	30.08	58.			S. W.	5	8	K. S.	Light rain.	Light rain.
Near Mouth of Big River	" 21	2.00 p.m.	30.04	53			0	0	10	S.	Overcast.	Overcast.
"	" 22	7.00 a.m.	29.88	50		45	N. E.	6	10	S.	Banked clouds with thunder.	Overcast.
Fort George	" 22	2.00 p.m.	29.73	73			N. E.	4	7	K. S.	Overcast	Overcast
"	" 22	9.00 p.m.	29.76	55			N.	0	10	S.	Overcast.	Overcast
"	" 23	7.00 a.m.	29.92	43		40	N. W.	6	10	S.	Fair.	Fair
"	" 23	2.00 p.m.	29.97	56			S. W.	5	8	S. K.	Very fair.	Very fair, brilliant aurora.
"	" 23	9.00 p.m.	30.14	48.			N. W.	3	0	0	Overcast.	Light rain early in a.m.
"	" 24	7.00 a.m.	30.24	39		42	W.	0	10	S.	Overcast	Overcast with fog.
"	" 24	2.00 p.m.	30.28	53.			N. W.	3	10	S.	Very fair.	Clearing to fair.
"	" 24	9.00 p.m.	30.34	47.			0	0	1	K.	Gloomy, overcast.	Overcast and misty.
"	" 25	7.00 a.m.	30.42	45.		41	N. W.	5	10	S.	Fair.	Clearing to fair.
Stromness Harbor	" 25	2.00 p.m.	30.47	60.			W.	3	4	K. S.	Very foggy.	Dense fog in p.m.
"	" 25	9.00 p.m.	30.44	48			N. W.	4			Fair	Fair, cleared early in a.m.
"	" 26	7.00 a.m.	30.45	53.		40.	N. E.	2	6	K. S.	Very fair.	Very fair.
Grey Goose Island	" 26	2.00 p.m.	30.40	65.			S. E.	3	2	K. S.	Fair.	Fair.
"	" 26	9.00 p.m.	30.28	49			S. E.	1	5	K. S.	Very fair.	Very fair, fog during night.
"	" 27	7.00 a.m.	30.22	49			S. E.	1	2	K. S.	Very fair.	Very fair, strong wind.
Near Cape Jones	" 27	2.00 p.m.	30.18	[illegible]			N. W.	7	2	K. S.	Very fair.	Very fair
"	" 27	9.00 p.m.	30.24	49.			N. W.	4	1	K. S.	Dense fog.	Dense fog.
"	" 28	7.00 a.m.	30.28	45.		39.	S. W.	3			Fair.	Cleared early in a.m.
"	" 28	2.00 p.m.	30.27	50.			S. W.	4	5	C. K.	Very fair.	Fair.
Cape Jones	" 28	9.00 p.m.	30.17	46.			W.	5	0	0	Misty.	Misty.
"	" 29	7.00 a.m.	30.05	50.		40.	S. W.	5	6	K. S.	Gloomy	Light rain.
Bear Island	" 29	2.00 p.m.	30.03	65.			S. W.	6	9	K. S.	Heavy rain.	Overcast

Cape Jones	"	29 9 00 p.m	29 28	54		S W	6	10	S.	Heavy rain.	Rain and fog.
"	"	30 7 00 a.m	29 57	57	50	N W	1			Overcast, moderate gale.	Heavy rain and fog.
"	"	30 2 00 p.m	29 67	55		N W.	7	10	S	Overcast, moderate gale.	Overcast, moderate gale
"	"	30 9 00 p.m	30 00	49		N W.	7	10	S.	Overcast	Overcast, wind falling during p.m.
"	"	31 7 00 a.m	30 08	40	36	S W	4	10	S.	Fair	Clearing.
15 m. N. of Big River	"	31 2 00 p.m	30 07	47		S W	5	3	K S	Passing showers	Overcast.
"	"	31 9 00 p.m	30 08	40		W	6	10	S.	Detached clouds	Showers
"	Aug.	1 7.00 a.m.	30 24	51	36.	N.W.	5	9	K S	Fair.	Fair.
Grey Goose Island	"	1 2 00 p.m	30 31	53		S W	4	2	K S	Fair.	Fair.
W[illegible]	"	1 9 00 p.m	30 32	46		W.	1	2	C S	Passing showers	Passing showers
"		2 7 00 a.m	30 38	41.	41	S.	3	7	K S	Fair.	Passing showers
Loon Point	"	2 3 00 p.m	30 32	66.		S W	3	5	K S.	Banked clouds, thunder.	Fair
Fort George	"	2 9 00 p.m.	30 18	49		0	0	5	K C	Misty.	Fair.
"	"	3 7 00 a.m	30 17	48.	41	S	6	4	K S	Fair.	Fair
Stromness Harbor	"	3 2 00 p.m	30 13	62.		S W	7	5	K S.	Overcast.	Heavy rain during p.m.
"	"	3 9 00 p.m.	30 05	56		W	2	10	S.	Overcast, misty	Overcast
"	"	4 7 00 a.m	30 08	50.	43	E	1	10	S.	Overcast, misty	Overcast, misty.
James Bay	"	4 2.00 p.m.	30 01	50		E.	1	10	S	Foggy.	Foggy.
Spencer Island.	"	4 9.00 p.m	29 84	56		S W	1	9	S.	Light fog.	Light fog, strong wind.
"	"	5 7 00 a.m	29 68	60	41	W	6	5	K S	Overcast, gloomy.	Overcast, heavy gale.
North Twin	"	5 2 00 p.m	29 77	61		N W.	8	9	S	Gloomy.	Overcast, heavy gale.
"	"	5 9 00 p.m	29 82	61.		N W.	8	3	S	Gloomy.	Rain during night, moderate gale
"	"	6 7 00 a.m.	29 97	53	48	N W.	8	8	K S	Fair.	Clearing, moderate gale.
"	"	6 2 00 p.m.	30.16	56		N W.	7	5	K S.	Fair	Fair, strong breeze
"	"	6 9 00 p.m	30 16	48		N.	5	2	K S	Fair	Fair, strong breeze
"	"	7 7 00 a.m	30 24	55	33	S	5	3	K S	Fair.	Fair, strong breeze.
"	"	7 2 00 p.m	30 11	68		S	6	5	C K	Overcast.	Overcast.
"	"	7 9 00 p.m	30 09	52		S W	4	9	S	Misty.	Misty.
"	"	8 7 00 a.m	30 04	55	49.	S W	1	8	S.	Overcast, gloomy.	Thunder squall in a.m.
Agoomska Island	"	8 2 00 p.m	30 11	60		S.	2	10	S.	Overcast, ugly.	Overcast, strong gale.
"	"	8 9 00 p.m	29 90	52		S.	8	10	S	Fair.	Very strong gale during night.
"	"	9 7 00 a.m	30 19	50		N W.	8	5	K S.	Fair.	Wind moderating
"	"	9 2 00 p.m.	30 37	52		N W.	4	8	K S	Overcast, gloomy	Fair.
"	"	9 9 00 p.m	30 39	50		S.	1	9	S.	Overcast.	Overcast, gloomy
"	"	10 7 00 a.m.	30 31	57	41	S.	6	8	K S.	Fair.	Clearing.
"	"	10 2 00 p.m	30 13	57		S.	6	2	K S	Fair	Fair.
"	"	10 9 00 p.m	29 93	52		S.	4	5	K S	Fair	Fair.
"	"	11 7 00 a.m	29 78	58	51	W	4	5	K S	Overcast, gloomy.	Strong breeze, foggy
"	"	11 2 00 p.m	29 98	48		N W.	6	10	S.	Very fair.	Fair.
"	"	11 9 00 p.m	30 05	47		N W.	5	3	K S.	Very fair	Very fair
"	"	12 7 00 a.m	30 20	57	45	N W.	2	2	K S	Very fair	Very fair.
"	"	12 2 00 p.m	30 18	62.		S E	5	3	K S.	Overcast.	Fair
"	"	12 9 00 p.m	30 11	57		S.	2	9	S.	Very fair.	Light rain during night
"		13 7 00 a.m	30 16	58		W	3	1	K.	Very fair.	Very fair.
"	"	13 2 00 p.m	30 14	60		S.	5	3	K.	Very fair.	Very fair, brilliant aurora.
"	"	13 9 00 a.m	30 14	61		S.	4	2	K.	Fair.	Fair.
"	"	14 7 00 a.m	30 16	54		N E	5	4	C K.	Fair.	Fair.

PLACE.	Date.	Hour	Barometer corrected	Thermometer. Air	Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind	Amt. of cloud	Kind of cloud	Weather at time.	Weather during last interval
	1887.											
Cockespenny	Aug. 14	2.00 p.m.	30.22	57			N. E.	5	2	K. S.	Fair.	Fair.
Inner Ship Hole	" 14	9.00 p.m.	30.16	57			S. E.	2	5	K. S.	Fair	Light showers and fog
"	" 15	7.00 a.m.	30.10	62			S. E.	2	6	S.	Thunder showers.	Rain and fog.
Moose Factory	" 15	2.00 p.m.	30.14	57			N. E.	3	8	S.	Overcast	Clearing
"	" 15	9.00 p.m.	30.30	59			N. E.	2	4	K. S.	Fair	Fair.
"	" 16	7.00 a.m.	30.28	55		38	N.	1	5	K. S.	Fair	Overcast.
"	" 16	2.00 p.m.	30.18	60			N. E.	2	10	S.	Rain.	Rain during afternoon.
"	" 16	9.00 p.m.	30.00	57			E.	4	10	S.	Overcast	Clearing.
"	" 17	7.00 a.m.	29.80	[illegible]		50	S. W.	5	0	0	Very fair	Fair.
"	" 17	2.00 p.m.	29.73	[illegible]			W.	5	5	K. S.	Fair	Light rain
"	" 17	9.00 p.m.	29.65	60			W.	4	10	S.	Light rain	Light rain.
"	" 18	7.00 a.m.	29.88	65		52	W.	5	5	K. S.	Fair	Clearing.
"	" 18	2.00 p.m.	29.87	69			N. W.	6	8	K. S.	Overcast	Fair
"	" 18	9.00 p.m.	29.88	60			W.	6	2	K. S.	Fair	Rain during night.
"	" 19	7.00 a.m.	29.88	42		41	S. W.	6	10	S.	Overcast.	Overcast.
"	" 19	2.00 p.m.	29.95	50			W.	6	10	S.	Overcast.	Overcast
"	" 19	9.00 p.m.	30.10	46			W.	5	10	S.	Overcast.	Overcast.
"	" 20	7.00 a.m.	30.17	51		45	W.	5	10	S.	Overcast	Overcast
"	" 20	2.00 p.m.	30.04	53			N. W.	5	9	S.	Overcast	Overcast.
"	" 20	9.00 p.m.	30.02	48			W.	5	8	S.	Overcast.	Passing showers.
"	" 21	7.00 a.m.	30.02	52		45	W.	4	10	S.	Passing showers	Passing showers.
"	" 21	2.00 p.m.	30.16	52			W.	4	10	S.	Passing showers	Passing showers.
"	" 21	9.00 p.m.	30.08	48			W.	5	8	S.	Shower.	Passing showers.
"	" 22	7.00 a.m.	30.21	51		47	N. W.	3	8	S.	Overcast.	Passing showers.
Head of Tide, Moose River	" 22	2.00 p.m.	30.22	54			N. W.	2	9	K. S.	Passing showers	Passing showers.
Abbittibi Forks	" 22	9.00 p.m.	30.22	52			0	0	9	S.	Overcast	Overcast.
"	" 23	7.00 a.m.	30.20	50			0.	0	9	S.	Overcast.	Overcast
Gypsum Rapid	" 23	2.00 p.m.	30.18	52			0	0	9	S.	Gloomy	Overcast
Motocami Forks	" 23	9.00 p.m.	30.17	56			N. E.	6	10	S.	Overcast	Overcast
"	" 24	7.00 a.m.	30.20	45		45	N. E.	5	10	S.	Overcast.	Overcast.
Missinaibie River	" 24	2.00 p.m.	30.11	58			E.	3	9	K. S.	Overcast.	Clearing
Halfway Rapid, Missinaibie River	" 24	9.00 p.m.	30.13	54			0.	0	1	C.	Fair.	Overcast
" "	" 25	7.00 a.m.	30.14	42		37	N. W.	5	10	S.	Light rain	Clearing.
Missinaibie River.	" 25	2.00 p.m.	30.14	50			N. E.	5	8	K. S.	Detached clouds	Fair
Rabbit River, Missinaibie River	" 25	9.00 p.m.	30.11	50			0	0	2	K. S.	Fair.	Fair
" "	" 26	7.00 a.m.	30.11	41		35	0	0	0	0	Very fair	Fair
" "	" 26	2.00 p.m.	30.08	[illegible]			W.	3	4	K.	Fair	Fair
Cedar Island, "	" 26	9.00 p.m.	30.02	60			0.	0	7	K. S.	Fair	Very fair
" "	" 27	7.00 a.m.	30.08	[illegible]		32	0	0	0	0	Very fair	Very fair
" "	" 27	2.00 p.m.	30.03	[illegible]			E.	3	1	K.	Very fair	Very fair.

Washagami Rv., Missinaibie Rv.	"	"	27	9 00 p.m.	29 98	64			0.	0	0	0.	Very fair	Very fair.
"	"	"	28	7 00 a.m.	30 03	33		33	0	0	1	K.	Very fair.	Very fair.
Long Portage,	"	"	28	2.00 p.m.	29.49	60			S. W.	3	5	K. S.	Fair	Fair
"	"	"	28	9.00 p.m.	29 84	55			E	1	2	K. S.	Fair	Passing showers
"	"	"	29	7 00 a.m.	29 93	40		40	0.	0	0	0	Very fair.	Very fair
Conjuring Ho. Portage,	"	"	29	2.00 p.m.	29.65	68			S. W.	3	1	K.	Fair, light fog.	Very fair
10 m. below Kettle Portage	"	"	29	9 00 p.m.	29 52	60			0.	0	0	0	Very fair.	Very fair
" "		"	30	7 00 a.m.	29 54	87		37.	S. W.	1	8	0	Very fair.	Hazy
Kettle Portage		"	30	2 00 p.m.	29.47	74			S. W.	3	1	K.	Very fair, smoky	Hazy
Black Feather Rapid.		"	30	9 00 p.m.	29 41	60			S. E.	5	1	K.	Misty, fair	Hazy
" "		"	31	7 00 a.m.	29.49	53.		51	S. W.	2	1	K.	Haze, fair.	Hazy.
Rocky Island Portage		"	31	2 00 p.m.		77.			S. E.	5	7	C. K.	Haze	Hazy
Sandy Bay Portage.		"	31	9 00 p.m.		65			S. E.	3	10	S.	Overcast	Rain during afternoon
Beaver Portage		Sept	1	7 00 a.m.		54			0.	0	10	S.	Overcast, gloomy.	Overcast, misty
Albany Rapid		"	1	2 00 p.m.		69			N. W.	1	10	S.	Overcast, gloomy.	Overcast, misty
Devil's Rapid		"	1	9 00 p.m.		64			N. E.	4	10	S.	" light rain.	Light rain
Pond Portage		"	2	7 00 a.m.		47		46	N. E.	3	10	S.	Overcast	Light rain during night
"Two" Portages		"	2	2 00 p.m.					N. W.	4	7	K. S.	Light rain.	Rained all morning
Round Island		"	2	9 00 p.m.					0	0	5	K. S.	Fair	Clearing.
Brunswick Portage		"	3	7 00 a.m.					0.	0	0	0	Very fair.	Fair
St. Paul Portage		"	3	2 00 p.m.					S. W.	1	4	K.	Fair.	Very fair
Greenhill Portage.		"	3	9 00 p.m.					S. W.	3	6	K. S.	Fair	Fair
"		"	4	7 00 a.m.					0.	0	4	K.	Fair	Fair.
Barrel Portage		"	4	2 00 p.m.					S. W.	2	3	K. S.	Very fair.	Fair
Keg Portage		"	4	9 00 p.m.					S. E.	1	2	K. S.	Very fair.	Fair
Lake Missinaibie		"	5	7 00 a.m.					0.	0	10	S.	Overcast	Light rain during night
		1888												
Lake Missinaibie		June	3	9 00 p.m.	29.33				S.	3	8	S.		
Lake Missinaibie		"	4	7 00 a.m.	29.36	52		48	S.	5	3	K. S.	Blue sky, passing cloud.	Squally with rain
Keg Portage, Missinaibie River		"	4	9 00 p.m.	28 62	62	65		S.	3	0	0	Fair.	Squally with passing clouds.
"	"	"	5	7 00 a.m.	28.56	54.		53	S.	3	5	C.	Haze.	Cloudy.
Green Hill Portage,	"	"	5	9 00 p.m.	28.70	50.			S. W.	3	10	S.	Cloudy, rain.	Partly cloudy with thunder storm.
"	"	"	6	7 00 a.m.	28.80	35.		34	N. W.	3	10	S.	Overcast.	Thunder storms.
Brunswick Portage,	"	"	6	9 00 p.m.	29.19	30.	47		N. W.	1	0	0	Clear and fair.	Rain during a.m., cleared at 1 p.m.
"	"	"	7	7 00 a.m.	29.30	33		30	0	0	0	0	Clear and calm.	Showers during the night.
Devil Rapid	"	"	7	9 00 p.m.	29.13	49	108		S. W.	1	0	0	Clear	Fine bright day, cloudy in p.m.
"	"	"	8	7 00 a.m.	29 16	45.		31	0	0	10	S.	Overcast, gloomy.	Overcast.
Crow Rapid,	"	"	8	9.00 p.m.	29.08	49.			0	0	10	S.	Overcast	Overcast with light rain
"	"	"	9	7 00 p.m.	28 91	46		44	0	0	10	S.	Rain	Heavy rain all night.
"	"	"	9	9.00 p.m.	28 90	53			0	0	10	S.	Raining heavily	Continuous heavy rain all day.
"	"	"	10	7 00 a.m.	28 80	40		38	0	0	10	S.	Heavy rain.	Steady rain all night.
Black Feather Rapid	"	"	10	9 00 p.m.	28 86	41			0	0	0	0	Clear sky.	Stopped raining at 2 p.m.
"	"	"	11	7 00 a.m.	29 10	60		33	N. W.	3	1	K.	Passing clouds.	Fair.
Conjuring Ho. Portage,	"	"	11	9 00 p.m.	29 15	47.			0	0	0	0	Clear.	Fine clear day.
"	"	"	12	7 00 a.m.	29.21	68		37	N. W.	2	0	0	Blue sky.	Fair.
Long Portage,	"	"	12	9 00 p.m.	29.23	57.	70.		0	0	2	K. S.	Passing, detached clouds.	Partly overcast, squally.
"	"	"	13	7 00 a.m.	29 22	60.		47	W	4	3	K. S.	Detached clouds	Detached clouds, fair.
Cedar Island,	"	"	13	9 00 p.m.	29 23	65.			N	4	5	K. S.	Detached clouds	Detached clouds, fair.

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud	Weather at time	Weather during last interval.
	1888.											
Cedar Island, "	June 14	7 00 a.m	29.36	67.		55.	N.	2	5	K C.	Hazy.	Detached clouds, fair.
Abittibi Forks, "	" 14	9 00 p.m	29 50	56.			N.	6	10	S.	Squally with rain.	Squally and overcast.
" "	" 15	7 00 p.m	29 64	60		50.	N.	2	1	K C	Fair with haze.	Fair.
Moose Factory	" 15	9.00 p.m	29.66	49.			N.	4	4	K S.	Threatening, part cloudy.	Fine day.
"	" 16	7 00 a m	29.74	52.			N.	5	....	.....		
"	" 16	9 00 p.m	29 70	60.			N.	5	...			
"	" 17	7 00 a m	29 80	50.			W.	6	5	K S	Passing clouds.	Part fair, squally.
"	" 17	9 00 p.m	30 02	51.	75.		N.	2	0	0	Clear sky.	Very fair.
"	" 18	7 00 a.m	30 12	66			0.	0	1	K C	Fair.	Fair with detached clouds.
"	" 18	9 00 p.m	29 94	70.	81.		S.	2	10	S.	Rain.	Overcast with light rain showers.
"	" 19	7 00 a.m	29 93	70	79.		N. E.	2	9	K S	Nearly overcast.	Squally with rain.
Mouth of Moose River	" 19	9 00 p.m	29 98	64			N E	3	8	K S	Misty and overcast.	Fair, partly cloudy.
"	" 20	7 00 a.m	29 97	57.			E.	4	7	K S.	Haze with threatening sky.	Haze and much cloud
Between Moose River and Charleton Island	" 20	2 00 p.m.	29 93	59.			E.	2	3	K C	Haze and smoke	Haze but fair.
S.W. Point Charleton Island	" 20	9 00 p.m	29 84	60			N. E.	2	8	K C S	Smoke and part cloud.	Fair day with much smoke.
"	" 21	7 00 p.m	29 76	62			N. E	3	5	K C.	Fair.	Fair.
"	" 21	2 00 p.m.	29 67	77			N. E	1	8	K C.	Detached clouds	Fair.
"	" 21	9.00 p.m	29 58	60			N. E.	2	8	K S.	Haze with detached clouds.	Haze and smoke, fair day
E. Point Charleton Island	" 22	7 00 a.m.	29 50	66.			S. W.	7	-	K C	Squally and threatening.	Wind changed at 4 a m.
Carey Island	" 22	2 00 p.m	29 60	55			N W.	8	0	K S.	Squally with some fog.	Overcast with fog and squalls.
"	" 22	9 00 p.m	29 74	43			N W.	6	8	K S.	Heavy gale with fog.	Overcast with haze and high wind.
"	" 23	7 00 a.m	29 95	45.			N W.	5	10	S.	Overcast and foggy.	High wind with heavy squalls.
E Coast 16 m. S. of East Main Rv	" 23	2 00 p.m.	29.98	47.			N.W.	5	10	S.	Overcast and foggy.	Overcast and foggy.
" "	" 23	9 00 p.m	29 98	49			N W.	6	10	S.	Overcast and squally.	Overcast and squally, strong high wind
" "	" 24	7 00 a.m	29 98	67		47.	N.W.	4	10	K S	Overcast and foggy.	Fog and cloud, squalls and high wind.
" "	" 24	2.00 p.m.	29 94	55.			N.W.	7	10	K S.	Squally, overcast and gloomy.	Squalls with strong wind

E. Coast 10 m. S. of East Main River	"	25	7 00 a.m.	29 88	53	.....	N. W.	5	10	S.	Murky.	Showers at intervals.
H. B. Post, East Main	"	25	2 00 p.m.	29.82	65.	.....	N. E.	5	10	S.	Fog, gloomy, overcast.	Overcast with fog.
6 m. S. of Cape Hope Island	"	25	9 00 p.m.	29 84	50.	.....	N.	3	10	S.	Fog, gloomy, overcast.	Gloomy with fog.
"	"	26	7.00 a.m.	29 93	44	42	N. W.	6	6	K. S.	Haze with detached clouds.	Overcast to clear.
6 m. N. of Cape Hope	"	26	2 00 p.m.	29 99	62.	.....	N. W.	8	1	K.	Fair with heavy gale.	Smoky and fair, strong wind.
"	"	26	9 00 a.m.	30 12	42	.....	N.	3	0	0	Fair with haze.	Fair with haze and smoke.
"	"	27	7 00 a.m.	30 28	43	36	N.	1	1	C.	Fair with haze.	Fair with haze and smoke.
Paint Hills	"	27	2 00 p.m.	30 22	53	.....	N. W.	2	3	C.	Fair.	Very fair.
5 m. N. of Paint Hills	"	27	9 00 p.m.	30 25	53	.....	0.	0	8	K. S.	Detached clouds.	Fair with smoke.
30 m. S. of Big River	"	28	7 00 a.m.	30 30	73	.....31.	S. E.	1	4	C.	Haze with detached clouds.	Fair with detached clouds.
25 m. "	"	28	2 00 p.m.	30 19	67.	.....	S. W.	2	8	K. S.	Fair with haze and smoke.	Hazy.
20 m. "	"	28	9 00 a.m.	30 13	63.	.....	0	0	10	K. S.	Overcast with fog.	Hazy.
20 m. "	"	29	7 00 a.m.	30 01	60	35	S. E.	2	10	S.	Fog.	Overcast and foggy.
Fort George, Big River	"	29	2 00 p.m.	29 98	65.	.....	S. W.	3	8	K. S.	Misty and overcast.	Overcast and misty.
"	"	29	9 00 p.m.	29 54	60.	.....	S. W.	4	10	S.	Squally with showers.	Squalls with drizzling rain.
"	"	30	7 00 a.m.	29 95	45.	.....33.	N. W.	3	10	S.	Squalls and fog.	Squalls with rain and fog.
"	"	30	2 00 p.m.	30.18	52.	.....	N. W.	5	9	K. S.	Detached clouds with fog.	Very foggy.
"	"	30	9 09 p.m.	30 26	45.	.....	N. W.	4	0	0	No cloud, thin fog.	Very foggy, brilliant aurora.
"	July	1	7 00 a.m.	30.31	67.	.....	N. W.	3	7	K.	Detached clouds.	Detached clouds, foggy.
"	"	1	2 00 p.m.	30 24	70.	.....	N. W.	3	8	K. S.	Overcast.	Overcast.
"	"	1	9 00 p.m.	30 18	46.	.....	0	0	10	S.	Overcast and hazy.	Partly overcast, heavy dew.
"	"	2	7 00 a.m.	30 03	65.	46	S. E.	2	8	K. S.	Misty and dull.	Overcast.
"	"	2	2 00 p.m.	29 94	66.	.....	S. E.	2	10	S.	Foggy and dull.	Overcast with fog.
"	"	2	9 00 p.m.	29 80	61.	.....	S. E.	2	10	S.	Squally with fog.	Very squally with fog.
"	"	3	6 00 a.m.	29 53	62.	.....57.	S. E.	8	10	S.	Very squally with fog.	Rain and fog.
Big River	"	3	2 00 p.m.	29 52	73	.....	S. E.	4	6	K. S.	Fair and squally.	Clearing.
1st Portage, Big River	"	3	9 00 p.m.	29 50	68.	.....	0.	0	9	K. S.	Fair.	Fair and squally.
"	"	4	7 00 a.m.	29 42	61.	.....55.	S.	2	10	S.	Raining.	Overcast with light rain.
6 m. above 1st Portage	"	4	2 00 p.m.	29 32	63	.....	S.	3	10	S.	Heavy rain.	Heavy rain all morning.
"	"	4	9 00 p.m.	29 28	42	.....	0	0	10	S.	Heavy rain.	Heavy rain.
"	"	5	7 00 a.m.	29 50	47.	.....40.	N. W.	3	10	K. S.	Overcast and misty.	Stopped raining at 5 a. m.
At Big Bend, Big River	"	5	2 00 p.m.	29 68	64.	.....	N. W.	3	1	C.	Squally fair and haze.	Cleared at 9 a.m.
On 3 m. Portage	"	5	9 00 p.m.	29 67	68	.....	0	0	0	0	Fair.	Fair.
"	"	6	7.00 a.m.	29.67	45.	.....25.	0.	0	3	K. C.	Fair.	Fair.
"	"	6	2.00 p.m.	29.43	74.	.....	S.	3	2	K. C.	Very fair.	Very fair.
"	"	6	9 00 p.m.	29 24	65.	.....	0	0	9	S.	Showers.	Overcast with showers.
"	"	7	7 00 p.m.	29 28	43.	.....43.	S. W.	2	10	S.	Dull and foggy	Rain during night, foggy.

PLACE.	Date.	Hour.	Barometer corrected.		Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind	Amt. of wind.	Kind of cloud	Weather at time.	Weather during last interval.
	1888.											
On 3rd Portage to Bishop Roggan River	July 7	2.00 p.m.	29 41	71.	.....	.....	S. W.	2	9	K. S.	Dull.	Overcast.
On 5th " "	" 7	9.00 p.m.	29 45	45.		...	S. W.	3	5	K. S.	Fair.	Fair.
On 5th " "	" 8	7.00 a.m.	29 45	34	.....	31.	S. W.	1	0	......	Very foggy.	Overcast and foggy.
Wawichetochis Lake	" 8	2.00 p.m.	29 88	70.	73.	.....	S. W.	1	9	K. S.	Misty and dull.	Fair.
On 7th Portage to B. R. River	" 8	9.00 p.m.	29 24	60.	...	.....	0	6	10	S.	Heavy rain.	Overcast with heavy showers.
"	" 9	7.00 a.m.	29 32	40		31	N. W.	3	.....	.....	Very foggy.	Raining all night.
"	" 9	2.00 p.m.	29 10	61	63	..	N. W.	6	5	K. S.	Squally and misty	Fair and misty.
On 9th Portage to B. R. River	" 9	9.00 p.m.	29 20	51	..	.	N. W.	1	4	K. S.	Detached clouds	Detached clouds.
"	" 10	7.00 a.m.	29 09	41		32.	S. E.	2	10	S.	Overcast.	Light rain.
Awichmawigaunache Lake	" 10	2.00 p.m.	28.66	50	..		S. E.	1	10	S.	Heavy rain.	Heavy rain.
" "	" 10	9.00 p.m.	28 68	41	..	..	S. E.	1	10	S.	Dull and foggy.	Dull and foggy.
" "	" 11	7.00 a.m.	28 63	41	..	37	S. E.	1	10	S.	Heavy fog.	Dense fog
" "	" 11	2.00 p.m.	28 64	51	51		S. E.	1	10	S.	Dull and foggy.	Dense fog
17th Portage to B. R. River	" 11	9.00 p.m.	28 72	50.	...	.	0.	0	10	S.	Overcast.	Clearing.
"	" 12	7.00 a.m.	28 62	51.	.....	41.	N. E.	4	3	K. S.	Fair.	Fair.
Piagochiwi Lake	" 12	2.00 p.m.	28 92	72.	81.	.....	E.	6	4	K. C.	Fair.	Fair.
Abpecholetachits Lake	" 12	9.00 p.m.	29 04	40.	..	. .	N.	3	0	0	Very fair.	Very fair.
"	" 13	7.00 a.m.	29 10	47.		39	N.	3	3	K.	Fair.	Fair.
8th Fall Bishop Roggan River	" 13	2.00 p.m.	29 14	61.	*90s	...	N.	5	2	K.	Fair.	Fair.
Awahagnts Lake	" 13	9.00 p.m.	29 12	44	...		N. W.	3	0	0	Very fair and clear.	Clear.
"	" 14	7.00 a.m.	29 18	47	108s	30	N. W.	3	2	K. C.	Fair.	Fair.
Upper River	" 14	2.00 p.m.	29 14	60	..	..	N. W.	4	1	K. S.	Fair.	Fair.
H. of L. Portage from B. R. Rv	" 14	9.00 p.m.	29 10	49.			0	0	1	S.	Fair.	Fair.
"	" 15	7.00 a.m.	29 16	40	112s	35	0	0	1	C.	Clear.	Clear.
Apachich is River	" 15	2.00 p.m.	29 19	71	..	..	S. E.	2	0	0	Very fair.	Very fair.
Kahinskwao Lake	" 15	9.00 p.m.	29.18	63.	..	....	0	0	8	K. S.	Very clear and fair.	Very fair.
"	" 16	7.00 a.m.	29 18	59	123s	47.	S. E.	1	6	K. S.	Detached clouds.	Fair.
Chatachiwon Lake	" 16	2.00 p.m.	29.19	78.	.....	.....	S.	1	5	K. S.	Detached clouds	Passing showers.
10 ft. chute, Upper Big River	" 16	9.00 p.m.	29 12	57.			0	0	8	K. S.	Overcast.	Passing showers with hail.
"	" 17	7.00 a.m.	29.05	62	91s	56.	S. E.	1	10	S.	Overcast.	Overcast.
40 ft. " "	" 17	2.00 p.m.	29 08	69.	..	....	S.	4	8	K. S.	Misty.	Misty, passing showers.
At Big Bend "	" 17	9.00 p.m.	29 00	69	....	.	0	0	5	S.	Misty	Misty.
" "	" 18	7.00 a.m.	29.03	59.	74.	64.	S.	1	8	S.	Misty and smoky.	Smoke and mist, thunder storm.
Upper Big River	" 18	2.00 p.m.	28 93	68.	.....	.....	S. E.	2	9	K. S.	Overcast and misty.	Smoke.

* Maximum in the sun marked thus (s)

Pattawagan River	"	18	9.00 p.m.	28.79	58.			0	0	5	K S	Smoky.	Overcast and smoky.
"	"	19	7.00 a.m.	28.66	59		49	0	0	8	K S	Thunder storm.	Overcast with passing thunder storms.
"	"	19	2.00 p.m.	28.61	73.	*94s		S.	1	8	K S	Thunder storm.	Passing showers.
H. of L. Portage to W. Branch of B. R. River	"	19	9.00 p.m.	28.64	59			W.	1	10	S.	Heavy rain.	Heavy rain.
"	"	20	7.00 p.m.	28.64	57		55	N. W.	1	10	S.	Heavy rain.	Heavy rain.
"	"	20	2.00 p.m.	28.68	61			N. W.	4	10	S.	Overcast.	Stopped raining at 11 a.m.
Niowatawigachi Lake	"	20	9.00 p.m.	28.74	57			0.	0	8	S.	Overcast	Passing showers.
"	"	21	7.00 a.m.	28.78	5?		54	N. E	1	6	K S	Detached, banked clouds.	Passing showers.
Kabipkamow	"	21	2.00 p.m.	28.78	72	75		N. W.	2	8	S.	Overcast.	Passing thunder showers.
Kahipotawiew Lake	"	21	9.00 p.m.	28.74	60			0	0	3	S.	Squally.	Passing thunder showers.
"	"	22	7.00 p.m.	28.62	59		56	S.	2	6	S.	Passing showers	Passing showers.
Masquachi Lake	"	22	2.00 p.m.	28.70	64	81s		S. W.	4	6	K S	Detached clouds	Passing showers
"	"	22	9.00 p.m.	28.92	55			W.	3	5	K S	Detached clouds	Overcast, clearing.
Mishominewatcn Lake	"	23	7.00 a.m.	28.98	50		40	S	1	10	K S	Overcast.	Partly overcast.
"	"	23	2.00 p.m.	28.93	64	108s		N. W.	1	5	K S	Banked clouds	Passing showers.
"	"	23	9.00 p.m.	28.94	50			N. E.	1	6	S.	Raining.	Overcast with light rain.
Pespishagami Lake	"	24	7.00 a.m.	28.94	53		45	N. W	2	5	K S	Banked clouds.	Passing showers.
"	"	24	2.00 p.m.	28.95	62	85s		N. W.	2	7	K S	Passing shower	Passing showers.
8 ft. Fall Upper Lt. Whale Rv	"	24	9.00 p.m.	29.10	49			W	1	10	S.	Overcast.	Overcast
Canoe Route, 20 ft. Fall	"	25	7.00 a.m.	29.12	47		44	W	2	9	K S	Overcast.	Overcast
"	"	25	2.00 p.m.	29.25	66	82s		N. W.	3	7	K S	Detached clouds.	Detached clouds.
2 m. Portage, "	"	25	9.00 p.m.	29.38	45			0	0	10	S.	Overcast	Overcast, with fog
65 ft. Falls, "	"	26	7.00 p.m.	29.44	33		32	0	0	5	K	Fair.	Foggy early in morning.
H. B. Post Gt. Whale R. or Mantounuck Sound	"	26	2.00 p.m.	29.73	59.	63		N. W.	3	8	K S	Detached clouds	Fair.
"	"	26	9.00 p.m.	29.84	45			E.	1	0	0	Fair.	Fair.
"	"	30	9.00 p.m.	29.73	53.		50.	N. E	2	10	S.	Overcast	Overcast with showers.
"	"	31	7.00 a.m.	29.19	54		52	S. W	1	10	S.	Rain and fog.	Heavy rain with fog.
"	"	31	2.00 p.m.	29.43	49			S. W	3	10	S.	Rain and fog.	Heavy rain with fog
"	"	31	9.00 p.m.	29.62	52			S. W	3	10	S.	Dull and foggy.	Stopped raining at 6 p.m.
H. B. Post, Lt. Whale River	Aug.	1	7.00 a.m.	29.62	52		49	S. W	2	10	S.	Thick fog.	Foggy.
"	"	1	2.00 p.m.	29.66	54			S. W	5	10	S.	Fog and rain.	Fog with rain after 10 a.m.
"	"	1	9.00 p.m.	29.88	50			S. W	7	1	S.	Fog clearing.	Squally with fog
"	"	2	7.00 a.m.	29.94	53.		0	N. W	4	10	S.	Fog and rain.	Showers and fog.
"	"	2	2.00 p.m.	30.08	61	98s		N.	1	2	C S.	Fair.	Fair.
"	"	2	9.00 p.m.	30.02	48			S. E	3	2	K S.	Fair.	Fair.
Richmond Gulf	"	3	7.00 a.m.	29.92	57		46	E	7	8	K S.	Fair and squally	Very fair and squally.
"	"	3	2.00 p.m.	29.75	65			E.	7	10	K S.	Fair with squalls.	Strong wind fair.
"	"	3	9.00 p.m.	29.76	55			E	4	8	K S.	Passing showers.	Squally with passing showers.
"	"	4	7.00 p.m.	30.00	48			N. W.	2	0	K S.	Misty.	Fog and light rain.
"	"	4	2.00 p.m.	29.97	63.			N. W.	4	5	K S.	Fog clearing.	Foggy.
"	"	4	9.00 p.m.	30.03	51			N. W.	1	7	K S.	Fair	Fair.
"	"	5	7.00 p.m.	30.05	48		42	N. W.	1	4	K S.	Fair	Fair.
Top of Portage past 35 ft. Fall	"	5	2.00 p.m.	29.69				N. E.	2	10	S.	Overcast.	Cloudy.
65 ft. Fall.	"	5	9.00 p.m.	29.59	[illegible]			0	0	10	S.	Overcast.	Part cloudy.
"	"	6	7.00 a.m.	29.59	53		41	N. E	1	10	S.	Fog.	Fog

* Maximum in the sun marked thus (s).

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind	Amt. of cloud	Kind of cloud	Weather at time.	Weather during last interval.
	1888.											
Wachtiwan River	Aug. 6	2.00 p.m.	29.51	64.	..	..	N. E.	2	10	S	Misty and overcast.	Cloudy.
Portage from River Valley	" 6	9.00 p.m.	29.10	57.	....	....	N. E.	3	10	S.	Overcast	Passing showers
"	" 7	7.00 a.m.	28.84	61	...	54.	S. W.	6	9	K. S.	Passing showers.	Passing showers.
H. of L. Portage	" 7	2.00 p.m.	28.92	66.	....	....	S. W.	6	9	K. S.	Overcast.	Passing showers.
Portage to large lake on 2nd tributary	" 7	9.00 p.m.	29.06	55.	....	..	S. W.	2	9	K. S.	Overcast.	Passing showers
" "	" 8	7.00 a.m.	29.04	54.	....	44.	0.	0	9	S.	Overcast.	Overcast.
On Large Lake	" 8	2.00 p.m.	29.06	67	...		S.	2	8	S.	Cloudy.	Overcast.
On Large Lake on Clearwater Branch	" 8	9.00 p.m.	28.88	58	..	....	S.	1	10	S.	Overcast.	Passing showers.
" "	" 9	7.00 a.m.	28.63	58	.	55.	S. E.	2	10	S.	Overcast.	Overcast.
" "	" 9	2.00 p.m.	28.33	68	..	.	S.	2	7	K. S.	Fair.	Passing showers.
" "	" 9	9.00 p.m.	28.53	44	..	....	S. W.	3	10	S.	Squally, dull.	Heavy rain in afternoon.
" "	" 10	7.00 a.m.	28.59	40	..	35	S. W.	2	10	S.	Dull and squally.	Heavy squalls with rain.
" "	" 10	2.00 p.m.	28.61	42	...	.	S. W.	4	10	S.	Rain.	Rain.
" "	" 10	9.00 p.m.	28.88	42	.	..	S. W.	2	10	S.	Squalls, foggy.	Fog and squalls.
" "	" 11	7.00 a.m.	29.19	40	..	31.	S. W.	6	10	S.	Fog and high wind.	Squalls high wind with fog
Portage to Clearwater River	" 11	2.00 p.m.	29.30	55	....	....	S. W.	6	8	K. S.	Misty, strong wind.	Squalls, overcast.
Above Large Island, "	" 11	9.00 p.m.	29.42	40.	....	....	S. W.	3	9	K. S.	Fair.	Fair.
" "	" 12	7.00 a.m.	28.46	45.	....	37.	S. W.	2	5	K. C.	Fair.	Fair.
Natwacami Lake	" 12	2.00 p.m.	29.41	61.	....	....	S. W.	3	2	K. C.	Fair.	Fair.
Portage between outlets	" 12	9.00 p.m.	29.32	42.	....	....	S. W.	1	2	K. S.	Fair.	Fair.
"	" 13	7.00 a.m.	29.21	50	...	40.	W.	3	9	S.	Partly overcast	Partly overcast.
Clearwater Lake	" 13	2.00 p.m.	29.19	53	.	...	W.	3	10	S.	Rain	Heavy rain after 10 a.m.
Above Island, Clearwater River	" 13	9.00 p.m.	29.22	52.	....	....	W.	1	10	S.	Heavy rain.	Heavy rain.
" "	" 14	7.00 a.m.	29.12	47.	....	41.	N. E.	1	10	S.	Overcast.	Rain all night.
Large Lake on Clearwater Branch	" 14	2.00 p.m.	29.07	51.	...	...	E.	1	10	S.	Overcast	Overcast with rain.
H. of L. between Clearwater	" 14	9.00 p.m.	29.05	48	..	...	E.	1	10	S.	Heavy rain.	Steady rain all afternoon.
"	" 15	7.00 a.m.	29.05	47	..	32.	W.	1	1	K. C.	Foggy.	Rain in earlier part of night.
Portage to Wachtiwan Valley	" 15	2.00 p.m.	28.99	57	....	....	W.	1	0	K. C.	Overcast	Clearing
"	" 15	9.00 p.m.	29.04	53	.	...	S. E.	1	3	K. S.	Fair	Fair.
2 m. Portage to Gulf Lake	" 16	7.00 a.m.	29.04	50	..	47	S. E.	1	5	K. S.	Fair.	Fair.
"	" 16	2.00 p.m.	29.12	67	....	..	S. E.	6	3	K. S.	Fair.	Fair with strong breeze
Gulf Lake	" 16	9.00 p.m.	29.63	63	....	....	E.	8	8	K. S.	Squally, clouded.	Fair with stronge breeze
"	" 17	7.00 a.m.	29.85	48	...	41	W.	6	9	K. S.	Very squally.	Rain during night
"	" 17	2.00 p.m.	29.89	53	..	....	W.	2	8	K. S.	Passing showers	Squally

Richmond Gulf	"	17	9.00 p.m.	29.82	47			S.	3	3	K S	Fair.	Fair, brilliant aurora.
Coast N. of Lt. Whale River.	"	18	7.00 a.m.	29.70	45			S.	5	7	S.	Very squally.	Very squally.
"	"	18	2.00 p.m.	29.62	50			S W.	4	10	S.	Squalls with rain.	Rain all morning.
Little Whale River	"	18	9.00 p.m.	29.63	43			S W	3	10	S.	Overcast.	Squalls with rain.
"	"	19	7.00 a.m.	29.62	47		37	W.	4	10	S.	Overcast	Squalls with rain
"	"	19	2.00 p.m.	29.63	42			W	4	10	S.	Overcast	Overcast, strong wind.
"	"	19	9.00 p.m.	29.75	40			N.	6	10	S.	Rain shower.	Overcast
"	"	20	7.00 a.m.	29.85	39		36.	N W.	5	10	S.	Foggy.	Rain and fog
"	"	20	2.00 p.m.	29.93	40			W.	5	10	S.	Foggy.	Foggy.
"	"	20	9.00 p.m.	30.03	39			S	7	10	S.	Overcast	Overcast and foggy
"	"	21	7.00 a.m.	30.09	39		38	S W	6	10	S.	Overcast	Overcast
Little River	"	21	2.00 p.m.	30.18	44			S W	2	9	S & K S	Fog.	Fog.
"	"	21	9.00 p.m.	30.23	45			N W.	1	9	K S	Heavy fog.	Heavy fog.
"	"	22	7.00 p.m.	30.24	40		35	0	0			Very dense fog	Very dense fog.
Mamtounuck Sound	"	22	2.00 p.m.	30.19	47			W.	1			Very dense fog.	Very dense fog.
"	"	22	9.00 p.m.	30.04	42			N. E.	1	1	K S	Fair.	Fog cleared during afternoon
"	"	23	7.00 a.m.	29.87	48		38	S W	2	9	K S	Overcast	Squally.
"	"	23	2.00 p.m.	29.77	[illegible]			S W	3	10	S.	Passing shower.	Overcast
"	"	23	9.00 p.m.	29.76				W.	3	10	S.	Dull and foggy	Dull and foggy.
Mouth of Gt. Whale River	"	24	7.00 a.m.	29.69	39		39	W	6	10	S.	Rain with fog.	Rain with fog. Heavy gale all night.
"	"	24	2.00 p.m.	29.63	36			W	7	10	S.	Rain and fog	Heavy gale
"	"	24	9.00 p.m.	29.63	39			W.	7	10	S.	Rain and fog.	Heavy gale.
"	"	25	7.00 a.m.	29.82	40		38.	N W.	1	10	S.	Overcast and fog.	Rain and fog, wind fell at midnight.
20 m. S. of Gt. Whale River	"	25	2.00 p.m.	29.94	42			N W.	1	9	S.	Overcast with fog	Overcast with fog
Back Whale Harbour	"	25	9.00 p.m.	30.02	39			N W.	1	10	S.	Very foggy.	Foggy
"	"	26	7.00 a.m.	30.18	41		38	N E.	1			Dense fog.	Dense fog
Long Island	"	26	2.00 p.m.	30.21	45			N.	4	9	K S	Dull and misty	Fog clearing
Cape Jones	"	26	9.00 p.m.	30.30	42			N	4	3	K S	Fair.	Fair.
"	"	27	7.00 a.m.	30.45	39		37	N	3			Dense fog.	Dense fog.
Fort George	"	27	2.00 p.m.	30.42	45			N.	4	2	K S	Foggy.	Fog clearing
"	"	27	9.00 p.m.	30.33	40			N.	1	4	K S	Fair with fog	Fog clearing
"	"	28	7.00 a.m.	30.25	39		36	S.	2	8	K S	Detached clouds	Fair.
"	"	28	2.00 p.m.	29.93	51			S.	3	10	S.	Overcast and foggy.	Squally
"	"	28	9.00 p.m.	29.82	51			S.	2	10	S.	Dull and foggy.	Light rain with fog.
"	"	29	7.00 a.m.	29.82	48		40	N.W.	1	10	S.	Very foggy.	Light rain with dense fog
Mouth of Big River	"	29	2.00 p.m.	29.89	42			N.W.	4	10	S.	Fog.	Fog.
25 m. S. of Big River	"	29	9.00 p.m.	29.93	41			N.W.	3	10	S.	Dull with fog.	Fog.
"	"	30	7.00 a.m.	29.84	43		39.	S W	4	10	S.	Dull and foggy.	Fog.
Comb Hills	"	30	2.00 p.m.	29.75	50.			S.	5	9	S.	Overcast and misty.	Overcast
"	"	30	9.00 p.m.	29.73	42.			N.W	3	10	S.	Overcast	Overcast with light rain.
"	"	31	7.00 a.m.	29.94	40		38.	N W.	7	9	K S	Overcast, gale.	Strong gale.
"	"	31	2.00 p.m.	30.06	40.			N.W.	7	7	K S.	Strong gale, fair.	Strong gale
"	"	31	9.00 p.m.	30.18	36			N.W.	4	3	K S	Shower	Passing showers
"	Sept.	1	7.00 a.m.	30.01	41		36.	S W.	8	9	K S.	Strong gale.	Strong gale overcast
"	"	1	2.00 p.m.	29.85	43.			S.W	8	10	K S	Strong gale.	Showers of sleet
"	"	1	9.00 p.m.	29.74	45.			S.	4	10	S.	Overcast	Showers of sleet
"	"	2	7.00 a.m.	29.94	44.		41.	W.	8	10	S	Strong gale.	Showers, strong gale
"	"	2	2.00 p.m.	30.23	42.			W.	8	7	K S.	Strong gale.	Strong gale, foggy.

PLACE	Date	Hour.	Barometer corrected.	Thermometer. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt of wind.	Kind of cloud	Weather at time.	Weather during last interval.
	1888.											
Comb Hills	Sept. 2	9.00 p.m.	30.35	45			W.	1	5	K S	Fair.	Clearing
"	" 3	7.00 a.m.	30.32	38		35	S.	5	10	S.	Overcast.	Light rain
Paint Hills	" 3	2.00 p.m.	30.06	40			S. E.	4	10	S.	Squally.	Squally, overcast
5 m. S. of Paint Hills	" 3	9.00 p.m.	29.84	39			S. E.	6	10	S.	Dull, overcast.	Showers
"	" 4	7.00 a.m.	29.83	40		30	N.	3	10	S.	Fog.	Fog.
Cape Hope	" 4	2.00 p.m.	30.08	42			N.	8	10	S.	Dull and foggy	Fog
East Main River	" 4	9.00 p.m.	30.14	41			N.	7	10	S.	Rain and fog.	Rain and fog.
"	" 5	7.00 a.m.	30.25	35		32	N. E.	2	10	S.	Snow flurries.	Fog with snow flurries
Stratton Island	" 5	2.00 p.m.	30.47	37			N. W.	4	3	K S	Snow flurries.	Snow flurries, squally.
S. E. Point of Charleston	" 5	9.00 p.m.	30.54	38			S. W.	1	9	K S	Overcast.	Fair
"	" 6	7.00 a.m.	30.53	37		34	S. W.	2	4	K S	Fair.	Fair.
Mimistickewatan	" 6	2.00 p.m.	30.53	50			S. W.	1	1	K C	Very fair.	Fair.
"	" 6	9.00 p.m.	30.43	41			S. W.	1	3	K S	Fair.	Fair
"	" 7	7.00 a.m.	30.20	50		47	S. W.	4	5	K S	Fair, smoky.	Smoke
10 m. N. of Moose River	" 7	2.00 p.m.	30.05	54			S. W.	6	3	K C	Smoke fair.	Squally and smoky.
5 m. "	" 7	9.00 p.m.	29.93	60			S. W.	7	1	K S	Fair.	Squally
5 m. "	" 8	7.00 a.m.	29.74	51		54	S.	2	8	K S	Misty.	Misty
Moose River	" 8	2.00 p.m.	29.65	57			S.	2	8	K S	Misty.	Showers
Moose Factory	" 8	9.00 p.m.	29.40	58			S. W.	3	10	S.	Rain and fog.	Heavy thunder storm in afternoon.
"	" 9	7.00 a.m.	29.61	53		51	S. W.	4	10	S.	Rain and fog.	Rain and fog
"	" 9	2.00 p.m.	29.69	56			W.	4	10	S.	Dull.	Overcast
"	" 9	9.00 p.m.	29.77	55			W.	2	9	S.	Overcast	Overcast
"	" 10	7.00 a.m.	30.02	54		52	W.	2	9	S.	Overcast	Overcast
"	" 10	2.00 p.m.	30.17	53			W.	2	10	S.	Overcast	Overcast

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

SECOND REPORT

ON THE GEOLOGY OF A PORTION

OF THE

PROVINCE OF QUEBEC.

BY

R. W. ELLS, LL.D., F.G.S.A.

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ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., etc.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I have the honour to transmit herewith my second report on the Geology and Mineral resources of the Eastern Townships. It embraces the work of the past two years, and is intended to accompany the north-east quarter-sheet map of a part of the province of Quebec, which is the continuation to the northward of that published in 1886. Many miles of coast line have been surveyed, both along the shores of the St. Lawrence and on the islands lying in the channel, and a great extent of country has been traversed along the roads, many new ones having been opened up since the compilation of the map by Mr. Barlow in 1868. These have been plotted and reduced by Mr. N. J. Giroux, C.E., P.L.S., who has ably assisted me throughout the entire work, and these additions to the map render it much more complete and accurate.

Our thanks are due to many persons, more especially to the owners and managers at the various mining centres, for much kindness and for courteous assistance in furnishing statistics and other valuable information. The area north of the St. Lawrence has only been cursorily examined by us, collections of fossils having been made at several points.

I have the honor to be,

Sir,

Your obedient servant,

R. W. ELLS.

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By R. W. ELLS, LL.D., F.G.S.A.

The work of the past two seasons has been for the most part confined to that portion of the province lying to the south of the St. Lawrence River and embracing the counties of Megantic, Dorchester, Bellechasse, Levis, Montmagny, and l'Islet. In its economic aspect it includes the Chaudière gold-field, the asbestus deposits of Thetford and Broughton, and the iron and copper deposits of Leeds. A great part of the district, viz., that lying to the north-east of the Chaudière River, was examined by Mr. James Richardson in 1868. His report is the latest official publication in detail on that section of the country. In view, however, of the many new facts pertaining to the structure and the age of the several rock formations of the Eastern Townships which have been obtained since, the statements put forward in that report now require considerable modification. Area described.

Along the St. Lawrence, our examinations of the south shore extended from Pointe au Platon, about thirty-five miles above Levis, to River du Loup. Of this section a carefully paced compass survey was made as far east as Ste. Anne de la Pocatière, while on the north side our examination extended from the mouth of the Jacques Cartier River to Cape Tourmente. The group of islands which occupy the central portion of the river between Quebec to opposite St. Thomas were also surveyed from Orleans Island to Crane Island, both inclusive. Surveys.

The extension northward of the several geological formations described in the preceding report* was carefully traced. The extension of the anticlinal there, and previously in 1863† and in 1867,§ described as that of Sutton Mountain was found to continue, with a nearly direct course, to the rear of l'Islet, where our examination ended in this direction; displaying for a considerable part of the distance the series of crystalline schists, chloritic, talcose, and micaceous, which characterize

* Geol. Surv. Rep. 1886. Part J.
† Geol. of Canada, 1863, p.p. 247, 251.
§ Rep. of Geol. Survey, 1867-68, p.p. 7A and 8A.

it to the south-west. It is concealed at several points, however, by the overlap on the west of the black slate and quartzite series, regarded as of Cambrian age; while on the east it is flanked for a great distance by the volcanic portion of what is now described as Lower Cambrian. These rocks extend continuously to the north-east and constitute, in part at least, the gold-bearing series of the Eastern Townships. In this series there occurs a very considerable development of volcanic rocks, diorites, serpentine, &c.; but the areas of the latter, north of the great masses of Thetford, are comparatively limited. All the known areas of serpentine were carefully examined with a view to the presence of asbestus in workable quantity, and small veins were seen in nearly every locality; but the conditions for successful mining appear much less favourable in the smaller and detached masses than they are in those at the great mining centres of this industry, viz., at Thetford and Coleraine.

Objections to the term "Quebec Group."

The name "Quebec Group," which has for so many years been applied to much of the rocks of this portion of the province of Quebec, has become so misleading and unintelligible in view of the many new facts brought to light concerning its composition and structure, by the study of the past fifteen years and the many changes rendered necessary in consequence, that its further use appears not only undesirable but to a certain extent objectionable. It was applied by Sir W. Logan to a great series of sediments which were deemed to lie somewhere about the horizon of the Calciferous and Chazy formations. Dr. Selwyn and others, have, however, since 1876, pointed out that it has been found to embrace rocks ranging from the Pre-Cambrian to the Hudson R. or Loraine, both inclusive. An almost entirely new arrangement of the different formations which make up the group is therefore imperative. In the case of such portions of the original group, the horizon of which has been definitely determined, the proper name of the formation can be readily applied, while in the case of such portions, either distinctly fossiliferous, or closely related areas the exact position of which in the Geological scale may be doubtful, the terms Levis or Sillery, with their system classification, may be retained.

Various reports on the area in question, extending over a period of sixty years, have appeared from time to time, among which may be more particularly mentioned the following:—

Reports bearing on the subject.

Dr. J. T. Bigsby, 1827, Geól. Soc, London, Vol. I., p. 27. On the Geology of Quebec and vicinity.
Capt. Bayfield, R. N., 1845. On the Transition rocks, Canada.
Sir W. E. Logan, 1843., Geol. Rep., pp. 18-19.
" " " 1844., Geol. Rep., pp. 19-33
" " " 1845-46., Geol. Rep., pp. 101-114.

E. Emmons, M. D., 1847. Am. Mag., Geology of the Montmorenci.
Sir W. E. Logan, Geol. Rep., 1849-50. Geology of South side of the St. Lawrence, between the Chaudière River and Temiscouata Road.
" " " Geol. Rep., 1850-51. On the gold of the Chaudière Valley.
" " " Geol. Rep., 1852-53. On the geology of the North shore of the St. Lawrence between Montreal and Cape Tourmente.
Logan and Hunt, 1855. Esquisse Geologique.
James Hall, 1858. Communicated 1855. Can. Nat., Vol. III., Notes on the genus Graptolites, etc.; also Geol. Rep. 1857.
E. Billings, 1860. Can. Nat., Vol. V., p. 301. On some new species of fossils from the limestones of Pte. Levis, opposite Quebec.
Sir W. E. Logan, 1860. Can. Nat., Vol. V., 1860, p 472. Remarks on the fauna of the Quebec group, and the Primordial Zone of Canada, addressed to J. Barrande.
T. S. Hunt, 1861. Can. Nat., Vol. VI., p 91-95. On some points in American Geology—the Quebec group paralleled with the Taconic system of Emmons.
Logan, Barrande and Hall, 1861. Can. Nat., Vol. VI., p. 106. On the Taconic system, and on the age of the fossils found in the rocks of Northern New England and in the Quebec group.
Sir W. E. Logan, 1861. Can. Nat., Vol. VI., p. 199. Considerations relating to the Quebec group and the Upper copper-bearing rocks of Lake Superior.
E. Billings, 1861. Can. Nat., Vol. VI., p. 310. On some of the rocks and fossils occurring near Phillipsburg, Canada East.
E. Billings, 1861. Can. Nat., Vol. VI., p. 344. On the occurrence of graptolites at the base of the Lower Silurian.
Dr. T. S. Hunt, 1861. Can. Nat., Vol VI., p. 374. Mr. Barrande on the Primordial Zone in North America, and on the Taconic system of Emmons.
Dr. T. S. Hunt, 1862. Can. Nat., Vol. VII., p. 78. Note on the Taconic system of Emmons.
James Hall, 1865. Sec. II., Can. Org. Remains. Graptolites of the Quebec group.
E. Billings, 1861-65. Pal. Fos., Vol. I., p. 57. On some new species of fossils from the Quebec group, where their probable position from fossil evidence is stated.
" " " Pal. Fos., Vol. 1., p. 185. New species of fossils from the limestones of the Quebec group from Pt. Levis and other localities in Canada East.
" " " Pal. Fos., Vol. 1., p. 207. New species of fossils from the Quebec group in the Northern part of Newfoundland.
Jules Marcou, 1862. On the Taconic rocks of Vermont and Canada.
E. Billings, 1863. Can. Nat., Vol. VIII., p. 19. On the Parallelism of the Quebec group with the Llandeilo of England and Australia, and with the Chazy and Calciferous formations.
Sir W. E. Logan, 1863. Can. Nat., Vol. VIII., p. 183. On the Rocks of the Quebec group at Point Levis, letter addressed to Mr. Barrande.
T. Devine, 1863. Can. Nat., Vol. VIII., pp. 95 and 210. Description of a new Trilobite from the Quebec group.

Sir W. E. Logan. Geol. of Can., 1863, p. 225. The Quebec group.
" " " " p. 884. Supplement.
" " Geol. of Can., 1866, p. 3-5. Divisions and characters of the Rocks of the Quebec group.
Prof. H. Y. Hind, 1865. On the distribution of the Quebec group in New Brunswick.
James Richardson, 1866. Geol. of Can., p. 30-33. On the Geology of the Quebec group in the Eastern Townships.
" " 1866-69. Geol. of Can. On the region South of the St. Lawrence, between the Chandière River and the Temiscouata Road.
Dr. T. S. Hunt, 1878. Sec. Geol. Sur. Penn., Part I. Azoic rocks.
Dr. A. R. C. Selwyn, 1877-78. Geol. of Can., p. 2a, 9a. Observations on the Stratigraphy of the Quebec group and the older Crystallines of Canada, also 1881 Can. Nat., Vol. IX, p. 17.
Thos. Macfarlane, 1881. Can. Nat., Vol. IX, p. 91. Canadian Stratigraphy.
Dr. A. R. C. Selwyn, 1880-81-82. Notes on the Geology of the Eastern portions of the Province of Quebec.
R. W. Ells, 1881-82. Report on the Geology of the Gaspé Peninsula.
Dr. T. S. Hunt, 1883. Trans. Roy. Soc. Can. The Taconic question in Geology.
Dr. A. R. C. Selwyn, 1882. Trans. Roy. Soc. Can. The Quebec group in Geology.
Mr. F. D. Adams, 1880-81-82. Notes on the Microscopic Structure of some rocks of the Quebec group.
Sir Wm. Dawson, 1883. Appendix to Harrington's Life of Sir W. E. Logan, the Quebec group.
Dr. Selwyn, 1883. Reply to Sir Wm. Dawson.
Prof. Jules Marcou, 1884-88. Various papers on the Taconic question, and on Canadian geological classification.

It will be readily seen from the above list that the bibliography pertaining to the several formations found in the area under consideration is very considerable. Many of the reports have long been out of print, and are now inaccessible to the great majority of readers. In order that the subject may be more intelligible, we have thought it advisable, therefore, to present a short summary of the various opinions held by the great number of scientific workers in this field, and expressed, from time to time, in the publications above enumerated. More particularly is this thought to be desirable, in view of the great difference in the opinions stated in regard to the structure of the area in the report of 1863, and in sundry papers since 1877 by Dr. Selwyn, and which have reference more especially to that peculiar series of rocks known as the "Quebec Group." This term was first introduced by the late Sir Wm. Logan in 1860, and applied to a series of rocks, first particularly studied near the City of Quebec, and especially developed on the South side of the St. Lawrence opposite that city, which presented so many difficulties as to the correct interpretation of its structure

and position, as to warrant the giving of a special name to the rocks which composed it. The investigations of this group, which had been begun some years before that date, had always presented problems very difficult of solution, owing to the fact that it was held to embrace a great variety of rocks differing very widely in character from those in the immediate vicinity of the St. Lawrence, and to include both the fossiliferous shales near that river and the great series of crystalline rocks of the interior, or the prolongation of the Green Mountain Range of Vermont, which enters Canada near Sutton Mountain, and extends with some interruptions to the extremity of the Gaspé Peninsula. These were regarded as the equivalents of the fossiliferous series near Quebec, their different aspect being supposed to be due to a profound metamorphism by which not only the contained fossils were completely effaced, but their entire physical character altered from the ordinary shales, sandstones and conglomerates of the original deposits to the most highly altered schists, quartzites, dioritic and gneissoid rocks. The upper part of the series was also held to embrace sediments, which contained fossils of Utica or possibly Hudson River age, so that the curious anomaly was presented of one single group name which comprised rocks ranging from what has now been determined to be as old as the Huronian to the upper part of the Cambro-Silurian. An abstract of the views referred to will be presented under the latter heading.

The several geological systems recognized in the area examined during the past season are:— Systems recognized.

F. Devonian.
E. Silurian.
D. Cambro-Silurian.
C. Cambrian.
A. B. Pre-Cambrian.
Crystalline and Igneous rocks, volcanic and plutonic.
Superficial deposits.

F. Devonian.

In describing the distribution of the Gaspé series (see Geol. of Can., 1863, p. 427-29) allusion is made to an out-crop of fossiliferous limestone, which is found on the north bank of the Chaudière River, about midway between the Famine River and the village of St. George. The fossils from this locality were examined by Mr. Billings, who pronounced their aspect to be Devonian rather than Silurian.

During the past season, the extent of this outlier and its relations to the associated slates of the locality have been carefully ascertained. It was found to have a breadth along the face of the hill of about twenty chains, and to rest unconformably upon the black and grey slates and greyish sandstones of St. George, the basin-shaped synclinal, with the beds curving along the face of the cliff, being readily seen when viewed from the opposite side of the river. The underlying slates at this point dip south-east at a high angle.

Extent of the Devonian areas.

No fossiliferous rocks of a similar horizon appear on the south side of the Chaudière in any direction, in so far as yet observed, the outcrops of Silurian slates at the narrows of Lake St. Francis, decribed in Part J, Vol. II, Geological Survey, 1886, being the nearest in point of age. To the north-east the limits of the St. George basin could not be clearly determined, owing to the covering of soil and forest, but it is apparently of no great extent in this direction, as no indications of such rocks are seen on the road which extends for twelve miles up the east side of the Famine River, the rest of the country in this direction being an almost unbroken wilderness.

Further to the north-east, on the road leading to Ste. Justine, between the townships of Langevin and Ware, a very limited exposure of similar fossiliferous limestone rests on the black slates and hard grey sandstones. This is on lot 32, range IX, Langevin, at the summit of the ridge, midway between the crossing of the brook at the head of the Famine River and the corner of the road to Ste. Justine church. The breadth of this outcrop is not more than twelve to sixteen feet, and it is about the same in length.

These are the only areas of rock which may be said to belong to the Devonian system that are known to occur anywhere throughout the whole of the country to the south of the St. Lawrence, which is included in the north-east quarter sheet of the Quebec map. The exposures just described resemble patches which have escaped denudation. From the fossils collected in 1886 by Mr. Ami from the Chaudière locality the following species have been recognized :

Polypi.

Fossils.

1. *Favosites Gothlandicus*, Lamarck	Dev. and Sil.
2. *Favosites*, sp. indt	
3. *Syringopora Hisingeri*, Billings	Dev. (Cornif.)
4. *Diphyphyllum*	"
5. *Cyathophyllum* (?) sp	"
6. *Heliophyllum*, sp. indt	"
7. Crinoid fragments	

Brachiopoda.

8.	*Orthis*, sp. indt	
9.	*Strophomena rhomboidalis* Wilckens	Sil. and Dev.
10. 11.	*Strophodonta*, 2 sp.	Devonian.
12.	*Productus* (?)	"
13.	*Spirifera duodenaria*, Hall, var. or N. sp.	
14.	*Spirifera gregaria*, Hall, " "	
15.	*Spirifera*, sp. indt	
16.	*Atrypa reticularis*, Linn.....Dev. Some resembling *A aspera*, Schl.	
17.	*Leptocœlia flabellites*, Conrad	Dev.

Lamellibranchiata.

18.	*Paracyclas*, sp.	Dev.
19.	*Pterinea textilis*, Hall, var	Dev. and Sil.

Trilobita.

20.	*Proetus crassimarginatus*? Hall	Dev.
21.	*Phacops*, sp. indt	Dev. and Sil.

From the collection determined by Mr. Billings, in addition to the forms above enumerated we have:

Favosites basaltica, Goldfuss	Dev. (Cornif.)
Diphyphyllum arundinaceum, Billings	" "
Zaphrentis, sp. indt	Dev. and Sil.
Heliophyllum Oneidaense, Billings	Devonian.
Orthis seriatula, Hall	Dev. (Cornif.)
Chonetes, 2 sp	
Productus, small form	Devonian.
Spirifera acuminata, Hall	Dev. (Cornif.)
Cyrtia, like *C. rostrata*	" "

E. SILURIAN.

No rocks which could definitely be pronounced of Silurian age were seen in the area embraced in this quarter-sheet map. The red shales mentioned in the Geol. Can., 1863, p. 205, the horizon of which was regarded as probably about that of the Medina from the fact that they overlie the Hudson River shales on the Becancour River and at other places, were carefully but unsuccessfully examined along that stream for fossils. The most northern area, that in the seigniories of St. Jean des Chaillons and St. Pierre des Becquets, shews, in some of the smaller streams, the same character of red shales. From the known unconformity of the red shales of the Becancour to the underlying Loraine shale, it is probably safe to assume that they Areas of Silurian.

represent some portion of the Silurian system. Owing to the general lack of exposures, however, the extent of the areas so occupied must be largely conjectural.

D. CAMBRO-SILURIAN.

Former views. Many of the remarks in Part J, Vol. II., Geological Survey of Canada, 18-6, on the character and distribution of the rocks formerly supposed to belong to the Upper Silurian system, will apply equally to the area at present under consideration. On the map of 1869, which is the latest published by the Survey of a large part of this district, the area occupied by rocks of Silurian age included all that portion of the province lying between the state of Maine and a line drawn from near the north-west end of Lake St. Frances to the intersection of the Quebec boundary by the North-West Branch of the St. John River, in the township of Talon, crossing the Chaudière a short distance west of the village of St. Francis, Beauce. From the point mentioned in Talon, the northern limit of the Silurian was thought to extend in a tolerably direct course to the north-east, keeping along the international line to the northern part of Lake Temiscouata; the area being regarded as forming the prolongation in this direction of what was then held to be the great Silurian basin, lying to the east of the Sherbrooke and Stoke Mountain anticlinal.

The statements in Geol. of Can, 1863, p. 427–29, relative to the structure and age of the strata along the Chaudière River, in which the great series of slates, quartzites and felspathic rocks, now regarded as in part constituting the lowest portion of the Cambrian, are classed as of Silurian age, cannot now be accepted as correctly interpreting the geological structure of this area, since it has been ascertained that no clearly recognizable Silurian rocks exist in this area at all, while, in the portion of the province lying to the south, such areas are confined to limited and at times closely infolded basins.

Two principal areas. The formations pertaining to this system, and found in the area south of the St. Lawrence, range from the Hudson River downward to the Cambrian. The area may be readily divided into two portions, an eastern and western, the former including all that series which extends between the central anticlinal presently to be described and the United States boundary, the latter that situated between that anticlinal and the St. Lawrence River.

Eastern area. The former portion has been briefly alluded to in the preceding report, 1886,* and is the prolongation to the north-east of the great Cambro-Silurian area which lies between the Stoke Mountain range

* Geol. Sur. of Can., Vol. II., Part J, 1886.

and the Cambrian rocks of Lake Megantic and vicinity. In their northward extension these sediments present characters very similar to those already described for the southern area, consisting largely of dark-grey and blackish, sometimes plumbaginous slates with greyish sandstones, the former sometimes ochre-spotted and displaying, on weathered surfaces, the characteristic striped or banded aspect already referred to. Calcareous rocks are, as a rule, absent, though on the Upper Chaudière they are occasionally seen, and they have been reported by Mr. A. Webster, formerly of the staff of the Geological Survey, as occurring on the North-West Branch of the St. John River, a short distance below the Lac de la Frontière. The western limit of the principal area of these rocks on the Chaudière is supposed to be the valley of the Famine River, whence they are well exposed on the roads leading up the Chaudière and Du Loup streams, extending in this direction along the Kennebec road to the vicinity of lots 37-40, Kennebec Road Range, Linière. The western boundary, north of the Famine, presumably follows the course of that stream to a distance of several miles beyond the crossing of the road to Langevin, whence curving round, the Cambro-Silurian rocks widen out towards the head waters of the Etchemin River, the line between these and the Cambrian crossing the road from Mailloux to St. Magloire, about half a mile west of the latter place. The country in this direction is entirely unopened, except by the road to St. Magloire, through Roux and Mailloux, and that through Cranbourne and Ware to Ste. Justine or Langevin. Further north, no waggon-road exists south of the Taché road, but in the northern part of Roulette and Montmagny an old foot-path extends through the northern part of these townships, past the south end of Lac au Crapaud, in the direction of Lac à la Frontière, on the N. W. Branch of the St. John. On this path, about the line between ranges VI and VII of Talon, blackish clay slates, presumably of this series and similar in character to those described further south, appear. This outcrop probably marks the western limit of the Cambro-Silurian area in this direction, as the dark grey graphitic limestone already referred to as occurring on the St. John waters, is found a few miles further to the north-east, associated with similar slates. The country lying east from Ste. Justine and St. Magloire, in the valley of the Daaquam River, is generally low and apparently unbroken by any prominent ridges which might indicate the presence of areas of the metamorphic Pre-Cambrian rocks. Hay swamps are numerous and the banks of the stream are frequently lined with alders for some distance inland. From the notes of Mr. A. Webster, who descended the Upper St. John from Little Lake St. John, at the head of the South-West Branch, which stream forms the boundary between Maine and

Upper waters of the St. John River.

Observations of Mr. A. Webster

Quebec for about twenty-five miles, we learn that much of the country in that direction is also low and that rock exposures are rare, much of the water in the river being sluggish. Where observed, the ledges consisted of greyish sandstone and clay-slate, which from their description resemble very closely the rocks described as occupying the great Cambro-Silurian basin of the south-eastern part of the province. The Upper St. John is navigable for canoes only when the water is high. On both occasions, when we visited the Upper Chaudière, the water in the St. John was so low that we could not examine that stream. The route followed by Mr. Webster, in 1880, was by a road from Jersey to the new settlement of St. Zacharie de Metgermette, by way of Lake Abenaquis, which is at the head of the Abenaquis stream, an eastern branch of the Famine River. The land about this lake is stated by him to be generally good, the rocks in places being arenaceous slates and grey sandstones similar to those seen about St. George and Jersey on the Chaudière River. Boulders of green chloritic, epidotic and quartzose rock, which may have been derived from the ridges in the adjoining state of Maine, were observed. About Little Lake St. John, crops of oats, wheat and potatoes seen at the end of August were reported excellent, a similar soil, with clay slates underlying, being noted as at the settlement further west. It is very probable that in the valley of the Upper St. John, as well as in that of its main branch, the Daaquam, on the west, the rocks and the soil are similar. East of St. Magloire, the rocks seen were fine cleaved clay slates, having a north-west dip. On the North-West Branch of the St. John, between Lac à la Frontière and the main river, hard, altered greenish-grey sandstones were observed, with bands of greenish-grey clay slates, all dipping S. E. $< 75°-80°$; and containing, a short distance below the lake, interstratified beds of argillaceous, bluish-black limestone much cracked and traversed by seams of calcspar. The specimens of limestone from this locality resemble very closely the Cambro-Silurian limestone of Cookshire and Eaton, in which microscopic fossils were found, and which have been described in the last Report.*

Central area. Another area of somewhat similar rocks, separated from those just described by a ridge of Cambrian, is formed by the prolongation to the north-east of the St. Francis area, which, extending from the upper part of Lake St. Francis, through Lambton and Tring, reaches the Chaudière in a gradually narrowing band about midway between St. Francis and St. George. The rocks in this area consist for the most part of bluish-grey and blackish slates, at times ochre-spotted, with grey sandstones, presenting at times the characteristic banded

* Geol. Survey, 1886, Vol. II, Part J.

aspect on smoothed surfaces noted in the central basin to the south-east. What has been regarded as a narrow band of these rocks crosses the Chaudière and extends up the west side of the Gilbert River for a short distance, though its northern limit cannot be definitely ascertained, owing to the inaccessible wilderness character of the country in this direction. As a rule, these rocks are not so highly felspathic or quartzose as those of the underlying Cambrian system, although in places they carry quartz veins. An apparent unconformity between the rocks of this series and the harder quartzites which underlie them is seen at the south end of the lake in lot 3, range III, of Tring, the bluish slates dipping S. 35° W. $< 30°$, while the underlying quartzite dips S. 20° E. $< 20°$. Full descriptions of the rocks of this series have been already given in the Annual Report, 1886, Part J, and need not here be repeated. South of the Chaudière their structure is apparently that of a basin bounded on either side by well defined ridges or areas of Cambrian sediments, one of which is seen to cross that river just below the mouth of the Famine, while the other is well developed about the village of St. Francis, Beauce, and for several miles to the south-east. Its extension west of that village will presently be described. Certain areas of red and green slates and grey sandstones, which cross the Chaudière near the Colway River and extend to the north-east into Cranbourne, present features very similar to those found in the Sillery rocks of Quebec, and may indicate a synclinal of these sediments in this direction.

The second area of the Cambro-Silurian rocks above referred to as that in the vicinity of the St. Lawrence presents at several places many features differing from those in the area just described, and the formations are, for the most part at least, presumably of a later age, as indicated by the abundance of fossils found at many points. St. Lawrence area.

On the south side of the St. Lawrence, two miles above the wharf at St. Nicholas, which is about twelve miles above Lévis, the contact between the grey, sandy shales and sandstones of the Loraine and the red, green and black shales of the Sillery formation is well seen both on the beach and in the cliff. The beds along the line of fault for several yards are much crushed, but the general dip of the two series is S. $<65°$-$90°$. From the Loraine shales a small collection of fossils sufficient to show their horizon was obtained. These have been examined by Mr. H. M. Ami, who has recognized the following species:— St. Nicholas, fault.

Columns of *Glyptocrinus*, prob. *G. decadactylus*. Fossils.

1. *Arthrograptus quadrimucronatus.*
2. *Diplograptus*, sp. nov, (*D. Latior.*)

3. *Leptæna sericea*, Sowerby.
4. *Orthis testudinaria*, Dalman.
5. *Zygospira Headi*, Billings.
6. *Ambonychia radiata*, Hall.
7. *Orthodesma parallelum*, Hall.
8. *Modiolopsis*, sp. indt.
9. *Trinucleus*, sp., large form.

Utica-Trenton outcrop.

The rocks of this horizon occupy the shore continuously for nearly three miles and a half, the high dip, S. 10° E. < 50°-60°, being maintained. The strike of the strata being almost along the shore, no great thickness of beds is exposed. At the end of this distance a sharp overturn fold occurs in the grey beds, followed by a line of fault which brings up a series of highly bituminous black and brown limestones and dark shales, with hard, blackish or greenish cherty beds like those seen at the Marsouin, the dip of which is S. 15°-30° E. < 55°-80°. These contain fossils, among which were observed :—

1. *Dicranograptus ramosus*, Hall.
2. *Climacograptus bicornis*, Hall.
3. *Dicellograptus sextans*, Hall.
4. ? *Corynoides calycularis*, Nicholson.
5. *Leptoboloid* shell. Too imperfect for specific and generic reference.

St. Antoine and Ste. Croix.

The peculiar bands of cherty and shaly rocks from which these fossils were obtained extend along the shore in the direction of St. Antoine de Tilly for nearly a mile and a half, and at their most southerly outcrop are underlaid by the usual grey shales and sandstones of the Loraine formation, there being probably a line of fault at this place. Above this the latter are well exposed in the cliffs and on the river flats at low tide, where they can be seen to run in straight lines obliquely across the river towards the north shore for nearly a mile in some places. The strike of the several beds to the vicinity of the St. Antoine wharf is quite uniformly to the S. W. < 50°-70°, though several well defined anticlinals are seen in this distance, but above the wharf, the angle of the dip begins rapidly to decline to 30°, whence the beds become more horizontal, till at St. Croix wharf the inclination is not more than 6°-8°, the direction of the dip being south and the river flowing past the basset edges of the strata. For several miles north of St. Croix wharf the flaggy sandstones are thickly covered with fossils, from which the following forms were obtained :—

1. *Discina*, sp.
2. *Leptæna sericea*, Sowerby.
3. *Strophomena alternata*, Conrad.
4. *Orthis testudinaria*, Dalman.
5. *Orthis emacerata*, Hall.
6. *Zygospira Headi*, Billings.
7. *Anazyga recurvirostra*, Hall.
8. *Bellerophon bilobatus*, Sowerby.
9. *Murchisonia gracilis*, Hall.
10. *Ambonychia radiata*, Hall.
11. *Orthodesma parallelum*, Conrad.
12. *Lyrodesma*, sp.
13. *Trinucleus*, sp. nov.
14. *Calymene senaria*, Conrad.
15. *Dalmanites* or *Encrinurus*, sp.

Above Ste. Croix, towards Pointe au Platon, the shores of Ste. Croix Bay are generally low and boulder-strewn, and but few ledges are seen. The more westerly trend of the shore as we ascend the river traverses the lower beds of the Loraine or Hudson River formation till near the extremity of the point, which forms the sharp angle of the river below and opposite Port Neuf, where the upper beds of the Utica formation proper appear. These are highly bituminous, brownish-grey shales, with bands of hard dolomitic limestone, containing graptolites, and in character are like the rocks seen on the north side of the gorge below the Montmorency Falls. Only one fossil form was obtained from this point, viz., *Orthograptus quadrimucronatus*, Hall. These beds are very nearly flat or dip to the S. W. $< 2°$. They continue along the shore above the wharf for a mile, above which our measurements did not extend, as the next course of the river traverses the Loraine shales again, repeating the section seen at Ste. Croix. Pointe au Platon, therefore, and the cliffs in the immediate vicinity represent the only typical Utica rocks seen on the south side of the river in this direction. From the fault above St. Nicholas the line of contact there described between the Loraine and Sillery formations extends apparently in a direct line, as indicated on the geological map, 1866, to the Becancour River, where it is seen about fourteen miles above the mouth. On this river the rocks of the newer series are grey sandstones and shales, like those about Ste. Croix, and contain an abundance of fossils of like species, among which were found a *Diplograptus*, resembling *D. Hudsonicus*, a *Crania*, and a *Lingula*, *Orthis testudinaria*, *Zygospira Headi*, *Ambonychia radiata*, and a *Trinucleus* like that from Ste. Croix, besides a branching and frondose species of monticuliporoid coral.

Pointe au Platon.

Fault.

Becancour River.

These rocks are in contact by a fault, with the red, green and black shales and hard sandstones of the Sillery formation, which extend thence up the Becancour to the line of the Grand Trunk Railway at Lyster.

Jacques Cartier River to Pointe-aux-Trembles.

The country bordering the St. Lawrence on the north side from Portneuf, which is opposite Pointe au Platon, to Quebec is well described in the Geology of Canada, 1863. The paced section of the shore during the past season, from the mouth of the Jacques Cartier River eastward, passes over brownish and blackish bituminous shales, holding graptolites, with *Leptobolus insignis*, as far down as a point seventy-five chains west of the wharf at Pointe aux Trembles, where these sediments are immediately underlaid by grey nodular limestones of Trenton age. Throughout this distance the Utica beds are nearly horizontal or range in dip from 2° to 8°, but show several low anticlinals on either side of Ecureuil Point, with several local twistings of the strata. The Trenton beds of Pointe aux Trembles are also thrown into a series of low undulations, the dips ranging from 10° to 20°, but near the northern exposure these become more abrupt, reaching angles of 40°. The contact between the Trenton and the Utica to the east of Pointe aux Trembles is sixty-four chains from the wharf, and is well seen for several hundred yards along the beach, the direction being at this place almost with the course of the shore. The whole exposed breadth of the Trenton anticlinal of Pointe aux Trembles is therefore only 140 chains. The beds at this place are simply a mass of fossils, many of which are beautifully preserved. A few forms only were picked up in our traverse among which were:—

Trenton fossils from Pointe-aux-Trembles.

1. *Heterocrinus simplex*, Hall, var. *Canadensis*, Billings.
2. *Monticuliporoid corals*, several sp.
3. *Leptæna sericea*, Sowerby.
4. *Strophomena deltoidea*, Conrad.
5. *Strophomena alternata*, Conrad.
6. *Orthis testudinaria*, Dalman.
7. *Dalmanites callicephalus* (?), Green.
8. *Calymene senaria*, Conrad (= *C. Blumenbachii*, Brongn.).
9. *Asaphus platycephalus*, Stokes (large sp.).
10. *Ceraurus pleurexanthemus*, Green.

Pointe-aux-Trembles to Cape Rouge.

Below this, to near the contact above Cap Rouge, the shore is generally low and marshy, with great mud flats, strewn with Laurentian boulders, and with points every few hundred yards composed of the same. Occasional ledges of brown and black shales of Utica aspect are seen, which, at about two miles and a quarter above the Cape Rouge contact, shade upward into greyish shales, with beds of greyish sand-

stone of the usual Loraine aspect. These dip south-easterly < 40°-50°, and one mile above the contact, hard, cherty shales are seen, with beds of conglomerate, from the pebbles of which *Orthis testudinaria* and *Leptæna sericea* were collected. Near the contact the beds are black and greyish shales and grey sandstones, which along the line of fault, as above St. Nicholas, are much crushed. The line of fault at this place is beautifully seen on the beach at low tide. Fault above Cape Rouge.

The rocks on the north side of the St. Lawrence, extending between Ancient Lorette and Cape Tourmente, were more particularly studied by Messrs. Giroux and Ami, who made careful collections of fossils at various points. Among these were Lorette, Charlesbourg, Templeman's Quarry, Montmorency Falls, Ste. Anne de Beaupré and St. Joachim. The distribution of the Trenton, Utica and Loraine formations, as given in the Geology of Canada, 1863, was found to be generally correct. North side St. Lawrence River below Quebec.

At Ancient Lorette the Laurentian gneiss occupies the bed of the St. Charles River, below the bridge at the gorge, which is reached by a flight of steps from the west bank. The gneiss is here overlaid directly by the Trenton formation, the lower beds of which for several feet are made up of recemented *débris* from the underlying gneiss, and these gradually pass upward into the highly fossiliferous, dark-grey, bituminous limestone. These rocks dip south-easterly < 10°. To the east of the village the gneiss also shows along the north side of the road leading to Charlesbourg for a mile or more. The Trenton horizon of the Lorette limestone is well seen from the following list of fossils collected in a short time from the beds at the foot of the fall, and which have a Black River facies in their lowest portion :— Ancient Lorette. Trenton rocks on Laurentian gneiss.

Fossils from Lorette.

1. *Prasopora lycoperdon*, Vanuxem (*P. Selwyni*, Nich.).
2. ? *Batostoma Ottawaense*, Foord.
3. *Pachydictya acuta*, Hall.
4. Several other branching *Polyzoa*, indt.
5. *Discina Pelopea*, Billings.
6. *Lingula Philomela*, Billings.
7. *Leptæna sericea*, Sowerby.
8. *Strophomena alternata*, Conrad.
9. *Orthis testudinaria*, Dalman.
10. *Orthis*, sp. nov. ?
11. *Skenidium* ? sp.
12. ? *Zygospira* or N. G.; This form occurs at Montmorency, both above and below the falls, and at Beauport, Charlesbourg, etc.
13. *Atrypa hemispherica*, Hall.
14. " " var. or n. sp., without plications along the

anterior margin, but marked by a few prominent concentric lines of growth.
15. *Bucania punctifrons*, Emmons.
16. *Bellerophon bilobatus*, Sowerby.
17. *Conularia Trentonensis*, Hall.
18. *Theca*, n. sp. This species occurs in the Black River limestone of St. Joseph Island, Lake Huron, and elsewhere.
19. ? *Ctenodonta dubia*, Billings.
20. ? *Pterinea Trentonensis*, Emmons.
21. *Ambonychia*, sp., with numerous fine flexuous lines radiating from the umbonal region to the anterior margin, where they are most prominent.
22. *Lituites undatus*, Emmons.
23. *Endoceras proteiforme*, Hall.
24. *Primitia Canadensis*, Jones, var. *nana*.
25. *Beyrichia*, sp. nov.?
26. *Asaphus platycephalus*, Stokes.
27. *Ceraurus pleurexanthemus*, Green.
28. *Calymene senaria*, Conrad (= *C. Blumenbachii*, Brongn.).
29. *Encrinurus vigilans*, Hall.
30. *Dalmanites callicephalus*, Green.
31. *Trinucleus concentricus*, Eaton.
32. *Illænus Milleri*, Billings.

Lorette to Ste. Foye.

The road from Lorette to Ste. Foye shows but few ledges. After descending the slope of the ridge on which the former village is situated, the country is low towards the line of the Lake St. John Railway. A few outcrops of brown bituminous shale were, however, seen in ditches and cuttings, and these were of Utica aspect.

Lorette to Charlesbourg.

From Lorette to Charlesbourg no rocks are seen other than those of the Trenton and Utica formations, with the exception of the ledges of Laurentian gneiss north of the road already referred to. At a small brook about one mile west of Charlesbourg church brown bituminous shales contain *Leptobolus insignis* in abundance, with *Orthograptus quadrimucronatus* and a *Climacograptus*—all Utica forms. Similar rocks are seen fifty yards north of the church, dipping south-easterly at an angle of 40°, and striking almost directly across the road. From these were obtained, in addition to the forms noted above, *Leptograptus flaccidus*, a *Strophomena*, a specimen like one from the Montmorency Falls, *Bellerophon bilobatus*, *Leperditia (Primitia) cylindrica*, *Triarthrus Becki*—all species of Utica age. About 500 yards north of the church, on the east side of the road, Templeman's quarry is situated in dark-

Fossils.

grey limestone, the beds being nearly horizontal. The limestone strata, which are highly fossiliferous, are separated by thin partings of black shale, an occurrence common to this formation at other points. A natural pit, over eighty feet deep, in the bottom of the quarry, gives a good section of the strata, and the owner stated that the same character of rocks extended all the way to the bottom, or at least as far as he could ascertain, and that he did not know on what the limestone rested, as the bottom of the formation had not been reached. From the beds of the quarry the following species were obtained :— Templeman's quarry.

1. *Pachydictya acuta*, Hall.
2. *Ptilodictya falciformis*, Nicholson.
3. *Prasopora lycoperdon*, Vanuxem (= *P. Selwyni*, Nicholson.).
4. *Crania*, sp. indt., parasitic on *End. proteiforme*.
5. *Endoceras proteiforme*, Hall.
6. *Schizocrania*, or *Discina*, sp.
7. *Lingula riciniformis*, Hall.
8. *Leptæna sericea*, Sowerby.
9. *Strophomena alternata*, Conrad.
10. *Strophomena ?* n. sp., same species as at Montmorency.
11. *Orthis testudinaria*, Dalman.
12. *Calymena senaria*, Conrad.

South of Charlesbourg the slope of the hill to the flat country, as at Lorette, shows ledges of brown bituminous shales of the Utica, with south-easterly dip $< 45°–50°$. Beauport. Parent's quarries.

Near Beauport the Trenton limestone is seen in great ledges along the road leading to Montmorency, in a nearly horizontal position, while the Utica shales, somewhat highly inclined, occur a short distance south of the road. From Parent's quarries, at this place, Mr. St. Cyr, of Quebec, has obtained both Trenton and Utica forms, among the former of which may be mentioned :—

1. *Prasopora lycoperdon*, Vanuxem.
2. *Amplexopora discoidea*, James.
3. *Lingula obtusa*, Hall.
4. *Strophomena deltoidea*, Conrad.
5. *Camerella hemiplicata*, Hall.
6. *Conularia Trentonensis*, Hall.
7. *Orthoceras anellum*, Hall, or a closely allied sp.
8. *Calymene senaria*, Conrad.
9. *Ceraurus pleurexanthemus*, Green.
10. *Asaphus platycephalus*, Stokes.

From the beds of Utica at this place were obtained :—

1. *Schizocrania filosa*, Hall.
2. *Leptæna sericea*, Sowerby.
3. *Lyrodesma pulchellum*, Emmons.
4. *Endoceras proteiforme*, Hall.
5. *Asaphus Canadensis*, Chapman.

Montmorency Falls.

The rocks of the Montmorency Falls, near the junction of the Montmorency River with the St. Lawrence, eight miles below Quebec, have for many years been the subject of geological investigation. The contact of the horizontal beds of the Trenton with the Laurentian is well seen in the river at the brink of the fall and for several miles up the stream, while at the foot of the fall the Trenton beds are almost entirely absent, and the overlying Utica is brought against the face of the Laurentian cliff, which here has a vertical height of about 260 feet, but in a highly inclined position, having a dip of nearly 60°, a state of things which can only have been brought about by a heavy fault. This fault can be traced westward past Beauport, whence it trends to the north-west, and strikes just across the rear of Charlesbourg, the beds at which place have already been described. Carefully located collections of fossils have been made on several occasions, both from above the falls and below in the gorge, but no species known to be older than Trenton have been found, and it seems clear, from the evidence of the fossils and from the character of the sediments, that the conclusions stated by Sir Wm. Logan in the Geology of Canada, 1863, as to the structure at this place, and subsequently by Dr. Selwyn in sundry papers, are clearly maintained.

Contact of Trenton and Laurentian.

Fault.

River above the falls.

Above the falls the bed of the river is composed of true Laurentian gneiss, which is seen on the very edge of the cliff when the water is low, while the banks of the stream on both sides are made up of the Trenton limestone, which is highly fossiliferous. The lowest beds of the Trenton in places consist of a re-composed rock made up of the *débris* of the Laurentian gneiss, cemented with sand and calcareous matter. These beds rest directly upon the gneiss, and frequently fill up irregularities in its surface. They range from a foot to three feet or more in thickness, and shade upward into the fossiliferous limestone of the Trenton, from the lowest beds of which the following species were obtained :—

1. *Pachydictya acuta*, Hall.
2. *Prasopora lycoperdon*, Vanuxem.
3. *Solenopora compacta*, Billings.
4. *Lingula curta?* Hall.
5. *Leptæna sericea*, Sowerby.
6. *Strophomena alternata*, Conrad.

7. *Orthis testudinaria*, Dalman.
8. *Orthis pectinella ?* Conrad.
9. *Anazyga recurvirostra*, Hall.
10. " ? Form not recognized, but very common here and elsewhere, and often referred to *Zygospira modesta*, Say.
11. *Vanuxemia*, sp. indt.
12. *Conularia Trentonensis*, Hall.
13. *Bellerophon bilobatus*, Sowerby.
14. *Bucania punctifrons*, Emmons.
15. *Murchisonia gracilis*, Hall.
16. " *perangulata*, Hall.
17. *Orthoceras*, sp. cf, *O. anellum.*
18. *Harpes*, sp. portion of glabella and cephalon.
19. *Encrinurus vigilans ?* Hall.
20. *Asaphus platycephalus*, Stokes.
21. *Ceraurus pleurexanthemus*, Green.
22. *Illænus Milleri*, Billings.

In the beds in the cutting on the road west of the bridge and in the cliffs in front of Mr. Hall's house at the head of his steps, *Trinucleus concentricus* is very abundant. Ravine below the falls.

Below the falls the Trenton limestones are almost entirely wanting in the section, the fault having obliquely cut the measures and brought the Utica shales with a thin band of the upper Trenton against the foot of the cliff. Occasional patches of hard sandstone or grit are seen in the lower part of the face of the cliff of Laurentian gneiss, but these appear to be portions of the lowest bed of the Trenton mentioned above, rather than the remains of any older formation, while the cliff is for the most part flanked by the thin limestones and black or brown bituminous shales of the lower part of the Utica. A ravine makes in on the east bank from the front of the fall for some distance, and marks the line of division between the Laurentian and the fossiliferous sediments. From these latter a good collection was made, both from the bottom and the east side of the ravine, among which are recognized :

1. *Hyalostetia*, or similar sponge spicules.
2. *Diplograptus*, sp.
3. *Climacograptus*, sp.
4. *Reteograptus Eucharis*, Hall ; small form.
5. *Orthograptus quadrimucronatus*, Hall.
6. Plate of a *cystidean* or *crinoid*, resembling *Glyptocystites* or *Glyptocrinus.*
7. *Lingula curta*, Hall.

8. *Leptobolus insignis*, Hall.
9. *Leptæna sericea*, Sowerby.
10. *Orthis testudinaria*, Dalman.
11. " ? A form apparently new and occurring in the Trenton and Utica from the Falls to Lorette.
12. *Serpulites dissolutus*, Billings.
13. *Illænus*, sp.
14. *Calymene senaria*, Conrad (= *C. Blumenbachii.*).
15. *Triarthrus Becki?* Green.
16. *Primitia*, sp. Apparently undescribed.

Mr. Ami remarks that the above fauna is pre-eminently Utica in facies, with an evident admixture of a few Upper Trenton species obtained from the lowest calcareous beds which crop out in the ravine. From the presence of certain typical Utica forms, no doubt can exist as to the exact horizon to which the strata there seen belong.

Section from foot of fall to mouth of river

The section of brown bituminous shales which extends along the north side of the gorge between the foot of the fall and the mouth of the river shows a probable repetition of the Utica beds near the outer extremity, and here the fossils found indicate a Utica horizon similar to that found on the east side of the ravine. These beds are, therefore, repeated by folding or by fault, indications of which latter are seen nearly midway between the foot of the steps and the mouth of the stream. It is also probable that both faults and folds occur in the space between this shore and the Island of Orleans, occupied by the north channel of the St. Lawrence.

The fossils obtained from the soft, brownish marls and disintegrating shales of the point at the mouth are as follows :—

1. *Diplograptus*, sp. indt.
2. *Climacograptus*, sp.
3. *Orthograptus quadrimucronatus*, Hall.
4. *Leptobolus insignis*, Hall.
5. *Endoceras proteiforme*, Hall.
6. *Triarthrus Becki*, Green. Common.

Montmorency Falls to Cape Tourmente

Further to the east, the Trenton is well exposed at Chateau Richer, from the beds of which much of the rock for the construction of the Lévis forts was taken, and which contains characteristic fossils. These are overlaid by the Utica, and at Ste. Anne de Beaupré the latter is followed by the greyish, sandy shales of the Hudson River or Loraine formation, the beds being similar to those seen at St. Pierre and Ste. Famille, on the north side of the Island of Orleans. At the River Ste. Anne also, at the road crossing, and in the creek three miles east of

St. Joachim, near the cheese factory, the Loraine formation is well displayed. According to the map prepared by Prof. Laflamme the Trenton occurs in limited areas directly upon the gneiss both on Ste. Anne River and on the Friponne, a small stream flowing down the mountain a short distance west of Cape Tourmente. The Utica also occurs on this stream, and a list of fossils from this spot is given in the Geology of Canada, 1863, p. 160. At Cape Tourmente itself the beds resting upon the gneiss consist of about twenty feet of conglomerate, grit and impure limestone, the former cemented by calcareous matter, just as on the Montmorenci, but yielding, in so far as searched, no fossils. Trenton on Laurentian at Cape Tourmente.

The most important area of Cambro-Silurian and Cambrian rocks, however, is that which occurs to the west of the great anticlinal of Pre-Cambrian strata, and which extends thence to the River St. Lawrence, occupying much of the flat country lying to the south-east of that river. This area embraces a large part of what has been styled in the earlier reports of the Survey the non-metamorphic portion of the Quebec Group, which was divided into the Levis, Lauzon and Sillery formations, all of which belong to lower horizons than those which underlie much of the flat plain contiguous to the river above the village of St. Nicholas, the strata of which, with their characteristic fossils have just been described. Sillery and Lévis formations.

Descriptions of many of these rocks have been fully given in the publications of the Survey, enumerated on pages 2–3. They present a great similarity of aspect throughout their entire extent, not only to the extremity of the Gaspé Peninsula at Cape Rosier, but even on the Island of Newfoundland, where they are well developed, and where favorable facilities are afforded, especially in the northern part of the island, for deciphering the peculiarly complicated structure of this group. They have been carefully studied there, first by Mr. Jas. Richardson in 1859-62, and subsequently by Mr. A. Murray, C.M.G., for some years director of the Geological Survey of the Island, whose map, published in 1877, contains the latest information bearing on this question as regards that locality. Newfoundland.

With the object of rendering as clear as possible the many conflicting statements which have arisen concerning the horizon and stratigraphical relations of this peculiar group of rocks, a brief abstract of the views held from time to time by the several observers in this field is here regarded as desirable.

The earliest account of the rocks around Point Lévis and Quebec is found in a paper by Dr. J. Bigsby, read before the Geological Society of London, December, 1827. They are there described as "1st, a slaty series, composed of slates and grauwacke, occasionally passing into a brown limestone, and alternating with calcareous Dr. T. Bigsby, 1827.

conglomerate in beds, some of which are charged with fossils; 2nd, a conchiferous brown and black limestone, sometimes based upon a calcareous conglomerate; 3rd, Gneiss." The author's chief reason for supposing the slaty series superior to the limestone is that "the latter is, in some situations, in immediate contact with the gneiss, while at others it passes into beds of the first series above mentioned, the conglomerate of which contains organic remains derived from the conchiferous limestone." The slaty series is said to "occupy the whole of the southern shore of the St. Lawrence, the Island of Orleans, and a considerable portion of the north bank of the river, including the ridge upon which Quebec is placed. In that neighborhood the mass of the deposit consists of a black and brown slaty limestone, inclined at very high angles, and alternating with semi-crystalline limestone and various conglomerates. The limestone contains several varieties of crystallized carbonate of lime, intermixed with quartz crystals and occasionally traversed by seams of bituminous matter, and near Cape Rouge and on the Plains of Abraham and Kilgraston, some of the strata consist of red and green clay slate. In the calcareous conglomerate, organic remains are mixed with fragments of clay slate, and the beds alternate with compact grey limestone and quartzose layers."

Earliest description of the rocks about Quebec.

"On the south side of the St. Lawrence, the slaty limestone of Quebec is no longer seen, but several new beds of conglomerate present themselves, one of the lowest of which contains trilobites, encrinites, corallines and other fossils, associated with vegetable impressions, probably of *fuci* and *amansiæ*."

"In the schistose beds near the mouth of the Etchemin are thin seams of coal. The horizontal conchiferous limestone is included between the slate series and the gneiss."

From the character and fossils of the limestone above described, Dr. Bigsby concluded it was the equivalent of the Carboniferous limestone of the English geologists.

Capt. Bayfield, 1845.

In a paper by Capt. Bayfield, R. N., published in the *Geological Journal*, 1845, on the transition rocks of Canada, the author states that "the Silurian limestone was traced from Lake Huron, where it contains the characteristic fossils of that formation, eastward across the Ottawa to Quebec, and was seen at various intermediate points along the north side of the valley of the St. Lawrence. The limestone at Pointe aux Trembles, six leagues above Quebec, contains, among other fossils, *Calymene Blumenbachii* and a species of *Chætetes*, which M. DeVerneuil informs me is allied to *C. petropolitana*. The limestone here dips to the south-east, conformably to the grauwacke which contains *Leptæna sericea* on the opposite side of the river. This latter

circumstance, together with the statements of an anonymous writer in the Canadian Review, that the limestone near the Falls of Montmorency declines gradually from the horizontal position till it finally dips at a high angle beneath the grauwacke on the opposite or south side of the river, and that a conglomerate, wholly composed of re-cemented fragments of limestone, containing the organic remains peculiar to Beauport, the Falls of the St. Charles and Indian Lorette, is one of the alternating members of the grauwacke or slate series, inclines us to assign to this limestone a position inferior to the grauwacke and slate, and low down among the Silurian strata. Considerable difficulty has been felt in admitting this, because the limestone has so very generally been found in nearly horizontal strata, resting immediately upon primitive rocks, in very near neighborhood to the highly inclined grauwacke and slate, but on the other hand it must be remarked that it has never, so far as we know, been found overlying the latter conformably."*

Early views of Sir W. Logan, Rep. Prog. 1843.

The first notice of these rocks on the part of the Geological Survey appears in the Report of Progress for 1843, published in 1845 by Sir William Logan, when the view was expressed that "the rocks of Point Levis came out from beneath the limestone of the St. Lawrence, and belonged to an apparently older horizon;" but in a foot note it is stated that "the bulk of evidence points to their superior position, which would make them the equivalents of the Hudson River and Loraine shale formation." In Report of Progress 1844, pp. 17-30, the characters of the several groups of rocks, which occur along the south side of the St. Lawrence, are very fully given under the head of conglomerate limestone, pillar sandstone and graptolitic shales, more particularly for that portion of the coast east of Cape Chat, and the statement is made on page 19 that there are "indications that as the south side of the St. Lawrence continues to present up to Quebec the same slightly oblique course to the run of the ridges, it is not improbable other divisions may crop out above Cape Chat which have a lower geological position than the strata in its vicinity," and on page 21, in speaking of the coaly matter which occurs in these strata and which was at that time thought by certain persons to be indicative of the presence of coal in this group, it is stated that "the rock containing it is supposed to be the equivalent of a part of the Hudson River group of the New York Geologists."

Rep. Prog. 1844.

Rep. Prog. 1847-48.

In Report of Progress, 1847-48, p. 57, the following statement is made regarding the age of the metamorphic portion of the Eastern Townships rocks: "The facts which have been detailed in the eluci-

* The slaty rocks of Quebec city, at that time supposed to be the same as those of Levis, have recently been stated to underlie the limestone unconformably by Mr. Jules Marcou.—A. R. C. S. See Memoirs Boston Nat. Hist. Soc., Vol. IV., 1888, plate fig. 6.

dation of the structure of the Green Mountains in their Canadian prolongation, would appear to make the plumbaginous sandstones and titaniferous red slates of the Seraphine range, in the seigniory of St. Hyacinthe, which are within a mile and a half of the Trenton limestone of that vicinity, equivalent to that of Granby; and these rocks, with their chromiferous calcareo-chloritic bands, to the dolomites and chloritic quartzose rocks of Kingsey, Shipton and Sutton; these again to the serpentine and quartz rocks of Potton, from which it would follow that the whole of the Green Mountain rocks, including those containing the auriferous quartz veins, belong to the Hudson River group, with the possible addition of the Shawangunk conglomerates." In their extension, it is stated on page 58 that "these recognized rocks of the Hudson River group have a continuous run from Lake Champlain along the south bank of the St. Lawrence to Cape Rosier."

Rep. Prog. 1849. In the Report of Progress, 1849, p. 18, a similar view is expressed under the head of Economic Materials, in connection with the reported presence of coal at Murray Bay and Bay St. Paul. The statement is there repeated that "a band of calcareous rocks of the age of the Trenton limestone of New York, which is well ascertained to be far below the Carboniferous deposits of North America, carried its outcrop in a continuous line from Grenville, on the Ottawa, to Beauport, below Quebec, on the north side of the St. Lawrence; and that another formation, contemporaneous with the Hudson River of New York, superior to the Trenton limestone, but also far beneath the same Carboniferous deposits, extended from Point Lévis to Cape Rosier." On page 32, the description of the series of rocks, which is stated to occupy the greater part of the country east of the Richelieu between the mountain belt and the St. Lawrence, may be given in condensed form as follows:—

1. Dark grey shales, interstratified with grey thin-bedded sandstones, often calcareous, and weathering yellowish-brown, and with grey, yellow weathering limestones. This series is fossiliferous, and holds shells and graptolites, and appears to be terminated by a set of bituminous shales and black limestones.

2. Grey, green and occasionally red shales with thin calcareous layers, with possibly a considerable deposit of red shale occasionally at top of the series. These shales appear occasionally to hold bands of calcareous conglomerate, cracks in which are filled with indurated bituminous matter.

3. Hard sandstones, varying in color from light grey to iron grey and sometimes slightly greenish; fine-grained and bedded, coarse-grained and massive; occasionally a conglomerate, the pebbles of which are frequently composed of Trenton limestone and contain Trenton fossils, sometimes these rocks are so calcareous as to be burnt for lime

4. Red and green shales, which are frequently interstratified with bands of light grey fine-grained sandstone, frequently calcareous.

5. Coarse-grained green sandstone, with scales of mica and spangles of plumbago, interstratified with red and green shales. The color of the sandstone appears to be due to the presence of chlorite; but red layers as coarse as the green, and holding nearly as much chlorite, are in some parts interstratified. The beds of both colors, which are almost always massive, are in general calcareous and often present bands of coarse conglomerate, with quartz pebbles, which sometimes appear to become mingled with pebbles and even boulders of grey limestone holding fossils, probably of the Trenton formation.

These rocks, in a highly metamorphic condition, were also, at that time, stated to constitute the mountain belt, "the inferior bituminous shales becoming plumbaginous slates, the grey sandstones being probably converted into quartz rock and talcose quartz slates, and in relation to this siliceous zone, there appear to be, in the metamorphic district, two magnesian belts shewing dolomite and serpentine, the equivalents of which in the unaltered rocks require farther investigation; the red slates and green sandstones seem to become chloritic, epidotic and ferriferous slates and less schistose forms of rock, and from the geographical position of what have been called the Corneous rocks, it appears not improbable they may be referable to this part of the deposit; but a larger number of facts must be ascertained before the various divisions of the metamorphic rocks can be clearly traced to their unchanged equivalents. The whole belong to the Lower Silurian age, and they are followed by others, which are shown, by the fossils held in some parts, to be Upper Silurian."

In the Report of Progress for 1852-53, the only reference to rocks of the Quebec Group is in regard to the mass of red and green shales, with the green sandstones, which extends from Cape Rouge along the river to Point à Pizeau, the age of which was supposed to be that of the Oneida conglomerates of the New York series. These rocks, which extend back from the river in the direction of Ste. Foye, were held to overlie the calcareous conglomerates, sandstones and black shales of the city and cliffs of Quebec, or their supposed equivalents, the rocks of Point Lévis, across the river, which were again held to be above the Trenton-Utica beds of Pointe-aux-Trembles, or to be about the horizon of the Lorraine shales. Rep. Prog. 1852-53.

In connection with the Paris Exhibition of 1855, a small volume, "Esquisse Géologique," relating to the Geology and Mineral wealth of Canada, was published by Logan and Hunt, in which, on page 49, it is stated that "an anticlinal axis divides the palæozoic formations of Canada into two basins. Upon the line of this axis the most recent Esquisse Géologique, 1855

formation, except the tertiary strata, is the lower part of the Hudson River Group, known by the name of the Loraine or Richelieu shales. In the valley of the Yamaska, an outcrop of Trenton limestone marks the anticlinal which separates the two basins. Not far to the east of this limestone, a series of sedimentary rocks which constitute the upper part of the Hudson River Group, is found, resting on the Richelieu shales, but which does not exist in the western basin, from which they have probably been removed. This series is composed of massive sandstone, greyish, often calcareous, associated with grey slates, green and red, toward their upper portion, and with other black shales, bituminous and graptolitic. In some portions of this formation the sandstone becomes a conglomerate and encloses large fragments of the lower fossiliferous formations. More often, however, the sandstones pass into a bituminous limestone,...... which contains fossils. This limestone is interstratified with siliceous and bituminous dolomite, which weathers yellow and contains carbonate of iron, and the dolomite seems in places to be replaced by a ferruginous and siliceous carbonate of magnesia. These are the rocks which form the cliffs of Quebec and Point Lévis, and have a thickness of over 300 metres."

"This formation at Quebec is succeeded by red and green shales, with thin bands of calcareous matter, and intercalated towards the summit with great masses of quartzose sandstone, often calcareous, and colored by a mixture of argillaceous matter which is greenish or reddish. This series of sandstones and shales, which has a total thickness of 1000 metres, has been named by Logan, the Sillery group, and appears to be the equivalent of that which has been named by the New York geologists the Shawangunk or Oneida Conglomerate, which in Central New York lies between the Richelieu shales and the Medina sandstone."

The comparative absence of organic remains in the Sillery formation was at the time noticed, these being principally confined to what was regarded as coprolitic matter, which was also held to occur with the graptolites of the underlying shales of Point Lévis.

These rocks were stated to extend to the extremity of the Gaspé Peninsula, and to be overlaid unconformably by over 2000 feet of fossiliferous Upper Silurian sediments, which in turn were followed by the Devonian and Carboniferous formations of the Bay of Chaleurs area. The whole was supposed to form a gradually ascending series from the Trenton limestone of the vicinity of Quebec to the Carboniferous of New Brunswick.

On page 56 *Ibid*, in the chapter on the Metamorphic Rocks it is stated, "that the rocks of the mountain region have been much metamorphosed and rendered crystalline by chemical action, so that the fossils are no longer recognizable. The rocks thus metamor-

phosed belong to the Hudson River group and to the Sillery formation." And again: "The changes which these sedimentary beds have undergone are often very remarkable, some of them passing into chloritic, micaceous and talcose schists, others into felspathic, hornblendic and epidotic rocks."

In 1855, Prof. James Hall presented his report on the series of graptolites collected at Point Lévis in the preceding year. This was published in the Geological Survey Report, 1857, in which the various graptolites of that locality are considered as belonging to the Hudson River group. Prof. James Hall, 1855.

During the years 1856-57, extensive collections of fossils were made from the rocks at Point Lévis, as well as from what were regarded as their equivalents near Philipsburg on the lower part of Lake Champlain and about Missisquoi Bay. These comprised not only graptolites but a considerable series of trilobites and other organic remains, the systematic study of which was undertaken by Mr. E. Billings. The result of his examination showed that, while the greater portion were new species, of those that were determinable, five were known in the Chazy limestone, and twelve in the Calciferous rocks of the Ottawa Valley, while the aspect of the undetermined species indicated rather the base than the upper portion of the Lower Silurian, as had so long been supposed. The conclusion was therefore reached by Billings that these rocks belonged really to the base and not to the summit of the Champlain division, and that the Lévis rocks were really older than the Trenton limestone. Conclusions arrived at by Mr. E. Billings.

These conclusions were first announced by Sir W. Logan in a letter to J. Barrande, and published in *Canadian Naturalist* December 31, 1860, vol. v., p. 472, and subsequently in the *American Journal of Science*, II, vol. xxxi, March, 1861, where the opinion was expressed that "this series of rocks, to which the name 'Quebec group' was now applied for the first time, represented a great development of strata about the horizon of the Chazy and Calciferous, brought to the surface by an overturn anticlinal fold, with a crack and dislocation running along the summit, by which the Quebec group is brought to overlap the Hudson River formation." Logan's views of the structure about Quebec, 1860-61.

The fault by which this overlap is produced is said to "come to the boundary of the province, not over a couple of miles from Lake Champlain. From this it proceeds in a gently curving line to Quebec, keeping just north of the fortress. Thence it coasts the north side of the Island of Orleans, leaving a narrow margin on the island, of the Hudson River and Utica formations. From near the east end of the island it keeps under the waters of the St. Lawrence to within eighty miles of the extremity of Gaspé. Here it again leaves a strip of the Hudson River or Utica on the coast." Course of the great fault.

Supposed age of the Quebec group, 1861.

It was there further stated that "the rocks along the south side of the river are arranged in a series of parallel synclinals, with many overturn dips, separated from one another on the main anticlinal by dark grey and black shales and limestones." From the fact that these shales and limestones, formerly regarded as of Hudson River age, apparently separated the synclinals of the Quebec group rocks, it was supposed that these must be considered older, and it was suggested that "the shales and limestones which may be subordinate to the Potsdam may represent the true primordial zone of Canada." In Vermont these rocks which were there recognized as the equivalent of the magnesian portion of the Quebec group, had long been regarded by Emmons as older than the Bird's Eye formation, a point now considered to be very fairly established by the new discoveries made near Quebec.

First division of the Quebec group.

With the new fossil evidence thus obtained, the history of the Quebec Group, by which name this series of rocks has since been known, assumed at once an entirely new aspect. The five divisions of the grauwacke series, given in Report of Progress for 1849, were now divided into two portions, of which the four first were styled "the Lévis formation," while the last was called "the Sillery." The details of the former are given in Geol. of Can., 1863, p. 227 29, where it is sub-divided into seventeen parts, having a total supposed thickness of 5,025 feet, at the summit of which was placed a series of greenish sandstones and red and green shales called the Sillery, with a total thickness of about 2,000 feet.

Views of Prof. Jules Marcou, 1861.

The published correspondence between Logan, Hall and Barrande called forth a reply from Prof. Jules Marcou, in a letter addressed to Barrande, and published in Trans. Boston Nat. His. Soc., 1861, in which marked exception was taken to the new views of Logan. In this letter Prof. Marcou discusses the age of the rocks of northern Vermont and their extension into Canada about Philipsburg, regarding these as of the age of the middle portion of his Upper Taconic, and "far below the Potsdam sandstone."

As the result of his study of the rocks about Philipsburg, Marcou claimed that the limestones of that vicinity as well as those of Highgate and Swanton, in Vermont, occurred simply as lenticular masses, with a framework of slate enclosing them, and that there appeared in the series a blending of the first and second faunas of the primordial zone. This peculiarity, he considered, was an illustration of the theory of colonies, first put forth by Barrande in Bohemia, by which colonies of the second fauna were enclosed in strata which contained the first, and he proposed to call these colonies, which were confined principally to the lenticular masses, "Precursors of Creation," that is the occurrence of species or generic types which received their full development only during the following period.

The same peculiar conditions of structure were held by him to apply to the rocks of Point Lévis and vicinity, the red, brown, green and black shales, with thin beds of sandstone, being held to represent the lower part of the Upper Taconic.

Prof. Marcou's theory of "colonies."

The theory of colonies held by Marcou to apply to the Philipsburg rocks was also extended to those of Point Lévis, two zones being established in this locality, of which the primordial fossils were principally obtained from a mass of limestone found on the Harlaka road in rear of the church of St. Joseph, and styled by him the "*Redoute*." This lenticular mass was regarded as a *lenticular primordial* of about the same age or a little younger than the lenticular primordial found in the Georgia slates of Swanton, Vt. The associated slates, limestones and magnesian conglomerates were considered to be a little higher in the series than the Georgia slates which represented the lower portion of the Upper Taconic.

His views of the structure of the Quebec and Lévis rocks

The presence of three other *lenticular primordials* in rear of Point Lévis, which occur between what is now the cemetery and the Main street, was noted, and it was claimed that these contained fossils which represented centres of creation or colonies pertaining to the second fauna, while the strata, together with the graptolitic shales and associated beds which extend to the shore of the river, were held to constitute the Point Levis group, and to be contemporaneous with the Philipsburg group of Vermont and Missisquoi county.

The rocks of the city and citadel of Quebec, and of the plain in which Beauport, Charlesbourg and Indian Lorette are situated, consisting largely of black shales, holding, in places, large boulders of limestone, were regarded by him as the equivalents of the Swanton slates of Vermont.

The views of Logan as to the complicated and folded structure of the rocks in rear of Point Lévis were not admitted by Marcou, who held that there was "no repetition of beds in this locality, and no synclinal axes," "and that the few foldings in the cliffs near the ferry are mere accidents, confined to a distance of a few feet, and without any effect upon the whole mass of the strata." The apparent discordance in direction between the slates and the limestones, at their contact, was held to be due to the globular form of some of the lenticular masses of the limestone which were enclosed, "the slates following the direction of the globular mass instead of running in a straight line, which gives to the whole, at first view, a sort of discordance of stratification which in truth does not exist."

Billings' reply to Marcou.

This letter of Marcou's drew forth a reply from Billings which appeared in the Can. Nat. 1863, vol. viii, in which he paralleled the strata of the fossiliferous Quebec group with those of the Llandeilo of

Similar rocks in Australia and England.

England and Australia, and with the Chazy and Calciferous formations of America, and showed conclusively, from a careful examination of the large collections of fossils from various points in the group that their position was really in the lower part of the Lower Silurian, instead of the upper where they had long been placed, on the one hand, or in the Primordial, beneath the Potsdam, on the other hand, as was maintained by Mr. Marcou. This view of Billings was concurred in by the leading English and Australian geologists who had found precisely similar forms in the strata of both countries where they could be definitely located. As for the occurrence of Chazy and Calciferous forms, Billings found that none of these occur in the neighborhood of Quebec, but that, in what he regarded as the equivalents of the group in Newfoundland, in the east, and near Philipsburg in the west, a few species found in both these formations were observed in the upper and lower beds respectively. He regarded the group as a "peculiar development of strata, the upper limit of which can scarcely be newer than the Black River, while the lower horizon is probably not far from the middle of the Calciferous."

Their Lower Silurian age asserted.

Geology of Canada, 1863.

In the Geology of Canada, 1863, p. 225-97, the views regarding the structure and stratigraphical position of the several rock formations which were then known as the Quebec Group are given in great detail. Their exact horizon is not however clearly defined, since "while from their geographical position, apparently superior to the Hudson River formation, these rocks belong in reality to an older group, which is developed to a great extent in Eastern Canada, and presents somewhat different characters in the various parts of its distribution." As the rocks were still under examination, the views there expressed were liable to modification as new facts might be brought to light. The group was divided into the Lévis and Sillery formations.

Thickness and character of the Lévis division.

Of these, the Lévis, which was held to compose the bulk of the group, was supposed to have a thickness of 5025 feet, and was subdivided into seventeen parts, in ascending order from the series of green and purple calcareo-magnesian and fucoidal shales, with limestone conglomerates at the base, to the red and green shales and sandstones which were supposed to shade upward into the overlying Sillery formation, provided the series was not an inverted one, of which however there appeared to be no definite proof, unless it might be the presence of an *Obolella*, which had the aspect of a Calciferous form in some of the shales of the supposed upper portion. As regards the position of the Sillery, it was there stated that "at the summit of the Lévis is an apparently interstratified series of greenish, drab-weathering sandstones with associated shales of different colors. In their upper part, the sandstones exceed the shales, varying in character from fine to

Supposed upper position of the Sillery.

coarse, containing small pieces of black and green shales, and with quartz pebbles, generally of small size and occasionally passing into a well defined conglomerate." "The sandstones are sometimes micaceous, with small spangles of graphite. They are frequently massive, the sandy layers being separated by partings of reddish and greenish shales, and are supposed to have a total thickness of about 2000 feet."

The distribution and characters of the rocks of this group are given in the volume above cited, throughout their whole extent in Canada, from their first appearance, north of the Vermont boundary to the extremity of the Gaspé peninsula, and the supposed positions of several anticlinals, by which the structure was rendered exceedingly complicated, were defined. As in the earlier reports, the great area of crystalline schists and associated rocks of the interior or mountain portion of Eastern Quebec was regarded as the metamorphic equivalent of the fossiliferous sediments of the vicinity of the St. Lawrence; that portion which is now held to constitute the oldest member of the townships series, viz., the Sutton Mountain Range, being supposed to represent, if not the whole, a portion at least of the Sillery formation. This aspect of the question has been discussed in the Report for 1886, but more fully in earlier papers by Dr. Selywn, see p. 8. In regard to the structure of the Shick-shock Range in the eastern section, while, as in the case of Sutton Mountain, it was regarded as a synclinal, it was not held to be necessarily of Sillery age, but might represent some of the finer masses which overlie the limestone conglomerates of the Lévis.

Supposed age of the crystalline rocks of the interior.

To the south-west, the group was made to include the series of limestones and shales about Philipsburg, together with the conglomerates, composed largely of their debris, the former of which had been regarded by Marcou as Primordial, and these were supposed to represent the lowest portion of the Lévis division. They here rest upon the Potsdam formation of this locality, known in part as the red sandrock of Vermont. The structure at this point is exceedingly complicated and has been a fruitful source of controversy.

Age of the Philipsburg rocks.

To the east, in Newfoundland, the sequence appeared to be more regular, the strata being in a nearly horizontal attitude over considerable areas, and much greater facilities are, in consequence, afforded for the study of the several formations. The characters of the various beds and their relative order of sequence, as shown along the shores of Belleile Strait, are given on pp. 287-93 (Geol. of Canada, 1863) from which it appears that the Laurentian gneiss, etc., of the north side of the strait is overlaid by the Potsdam formation, representing the red sand rock of Vermont and the Beauharnois sandstone, with an aggregate

Sequence in Newfoundland.

Thickness of the several divisions in Newfoundland.

thickness of 624 feet. This is succeeded in ascending order by the Calciferous limestones, etc., with a thickness of 1570 feet, which in turn are followed by a series of rocks, the Point Rich limestones, the position of which, as compared with the beds of Quebec, appears uncertain, but which in character and position are very closely allied to the Philipsburg limestones, and which have a total thickness of 1010 feet. These are succeeded by a series of grey sandstones and shales with limestone conglomerates, which are the undoubted equivalents, both in fossils and position, of the Point Lévis rocks, as well as of some portions of those near Philipsburg, with a thickness of 1400 feet.

To these apparently succeed the greenish sandstones and associated shales which represent the Sillery in this direction, and which were presumed to constitute the upper portion of the Lévis formation. As, however, the beds near their contact are tilted at a high angle, this apparent position is not fully established, as the next rocks in the sequence are those of the metamorphic series, so that it is possible that, by an overturn, the Sillery, which in places comes against the metamorphic rocks, may be properly regarded as a lower portion of the Lévis instead of an upper. Or possibly, what may be quite as likely, two distinct series of sandstones and quartzites, presenting considerable points of resemblance, have been confounded and both placed in the Sillery formation, of which one may really represent the upper part of the Sillery proper, in accordance with the supposed apparent structure at many points, while the other may belong to the underlying formation

The age of the group near Quebec is again stated (see p. 233, Geology of Canada, 1863) to "be about the horizon of the Chazy and Calciferous formations. The strata are brought to the surface by an overturn anticlinal fold, with a crack and great dislocation running along its summit, by which the group is made to overlap the Hudson River formation."

Quebec group divided into Lévis, Lauzon and Sillery, 1866

Subsequently (see Report of Progress, 1866, p. 4), for convenience, the Quebec group was divided into three parts—a lower, middle and upper—known by the names Lévis, Lauzon and Sillery, the lower of which was held to contain the Philipsburg limestones, the black slates above them, and that portion of the Levis shales and magnesian conglomerates included in the numbers 1-9 of the Orleans Island section described in Geology of Canada, 1863, p. 227. This lower division was distinguished by its general black and dark color, and furnished nearly all the fossils found in the Quebec group.

Lauzon, character of rocks.

The middle or Lauzon comprised the remaining divisions of the section mentioned above (Nos. 10-17). This was held more especially to comprise rocks of red, green and purple colors, poor in fossils, only three being known at that time, two *Lingulæ* and one *Obolella*, which

occurred near its summit, and in its metamorphic condition it was characterized by the ores of the more valuable metals. Near the base a mass of greenish glauconite shales occurs locally both on the Island of Orleans and at Point Lévis, while to the westward, the rocks appeared to be more magnesian than in the vicinity of Quebec. In this direction it was held that the black shales and limestones of the Lévis series were often immediately succeeded by a thick mass of dolomite, associated with diorite, the former of which, in the more metamorphic portions, was supposed to be replaced by important masses of serpentine, with soapstone and potstone. These magnesian deposits were also supposed to occur at two horizons in the Lauzon, one at the base, the other at the summit, and both were held to be accompanied by metallic ores. Sandstones, often a hard quartzite, occur as interstratified portions of both the Lauzon and Lévis divisions, and have often a considerable thickness. Many of these, while presenting features resembling the Potsdam sandstones, are clearly interstratified portions of the so-called Lévis formation.

Metalliferous zones.

The characters of the unaltered Sillery have been already given. In their altered condition these were still supposed to constitute the great bulk of the chloritic and epidotic schists and quartzites, and to pass, towards their summit, into more or less perfect gneiss. Considerable difficulty having been found in separating the magnesian bands at the summit of the Lauzon from the Sillery division, since the line of division came naturally between this band and the other rocks of the Lauzon beneath, it was regarded as most expedient to include the upper magnesian band in the base of the Sillery formation. The same view of the age of the gneisses of the Sutton Mountain section, as the altered portion of the Sillery with a synclinal structure, was expressed by Dr. Hunt. (See *Canadian Naturalist*, vol. vii, 1862.)

Character of the altered Sillery.

In Pal. Foss., 1861-65, p. 69, the occurrence of *Obolella pretiosa* is mentioned in a series of olive and greenish slates at the Grand Trunk Railway bridge over the Chaudière River, as well as in similar slates at Cape Rouge. These slates are stated to be interstratified with the Sillery sandstone as an upper part of the Quebec group, but the question as to whether this is their true position was left an open one. This specimen and a species of *Lingula* were the only fossils at that time known from the Sillery formation. The new views expressed as to the age of the Quebec group, resulting from the finding of such an extensive series of fossils, evidently gave rise to much confusion relative to the interpretation of the structure of the group, a fact clearly revealed by reference to the correspondence between Barrande, Hall and Logan, already referred to, the tendency at first being apparently to put the great bulk of these rocks into the Primordial zone, owing to

Pal. Foss., 1861-65.

Fossiliferous slates of the Chaudière.

the presence of so many species of Primordial aspect. This tendency was, however, to a large extent corrected by the able work of Mr. Billings and by the more careful collecting of fossils. The results of his examination of the many new species found in the Lévis rocks are stated in detail in Pal. Fos., vol. i, p. 57-96, where a full discussion of the subject from the palæontological standpoint is given. The conclusion therein arrived at regarding the age of the group was "that the true place of the Lévis formation is between the Potsdam and the Trenton, and not below the Potsdam, as still maintained by some observers." At the same time he pointed out the perfect identity of the species found in the slates and limestones of Cow Head, Newfoundland, where these rocks had been studied by Mr. Richardson in 1862, and later by Mr. Murray, with those found in the rocks of Point Lévis; as also the fact that the fauna from other points in the vicinity, while somewhat different, was closely related, indicating that they could be placed in the Quebec group, though not in the Lévis formation.

Conclusions of Billings as to the position of the Lévis, 1865.

Subsequently, in the consideration of the fossils from the northwest coast of Newfoundland, the parallellism between these rocks and those of Point Lévis is stated by Billings to be so close that there is no doubt the strata of the two localities belong to the same horizon. Owing to the greater horizontality of the measures, the facilities for deciphering their true structure were supposed to be much greater than at Point Lévis and the sections given in the Geology of Canada, 1863 were re-cast, and may be given in a condensed form, as follows:

Rocks of the group in Newfoundland.

	FEET
Quartzites, limestones, dolomites and slates of Potsdam age....	2,020
Magnesian limestones, dark grey and blackish grey limestones, representing the Calciferous formation..........	1,839
Light yellowish grey, grey and whitish, magnesian limestone, bluish-grey and black bituminous limestone, representing the intermediate beds between the Calciferous and Lévis, Upper Calciferous..........	1,361
Grey calcareous sandstones and black slates, also intermediate beds..........	700
Grey and white limestone conglomerate, black shales, etc., the shales holding the graptolites of the Levis shales, the conglomerates, the trilobites and other fossils of the similar rocks of Point Lévis..........	700
According to Billings, these are the true equivalents, of the Lévis shales and conglomerates.	
Greenish sandstone and red shales, Sillery..........	2,000

In Geol. Can. 1863, p. 879, a further comparison is made between the rocks of the Quebec group as seen in Quebec and their development

in Newfoundland, from which we learn that the lower portion or Potsdam of the latter locality is, from its lithological characters and the presence of *Paradoxides*, held to be clearly the equivalent of the red sand rock of Vermont. The graptolites, simple and compound, of the upper part of the section also leave but little doubt that these strata are the equivalents of those of Point Lévis, while at the same time the presence of *Maclurea ponderosa*, a thick-shelled and peculiar gasteropod, is common to these as well as to the Stanbridge conglomerates east of Philipsburg. The limestones of div. 2 (see above) contain fossils of Calciferous age and can be assigned to the base of that formation, while those of Philipsburg would belong to its summit. This clearly establishes the fact that the Philipsburg and Stanbridge series are newer than the red rock of Vermont, a view which is not contradicted by the stratigraphy or structural arrangement in the vicinity of Philipsburg. It follows from a consideration of the facts just presented, as is pointed out by Billings, Pal. Fos. p. 65, that "the rocks of Point Lévis, viz., the Point Lévis conglomerate limestone and graptolitic shales, are at least 2000 feet above the true Calciferous formation." From the fossils alone, he says, he "should judge that the Lévis formation immediately succeeds the Calciferous, though the physical evidence seems to show that this is not the case."

Comparisons between Quebec, Newfoundland and Philipsburg.

Position of the Lévis in regard to the calciferous.

Further, if we consider the section of the rocks of Philipsburg and vicinity (pp. 844-46, Geol. of Canada, 1863) we find that the conglomerates of Division D., which are elsewhere stated (p. 852) to be the Stanbridge conglomerates, are made up of the débris of the limestones constituting the upper part of division C. of the Philipsburg series, and regarded (see above) as of the Upper Calciferous horizon. This, of necessity, would place a physical break of considerable extent between the Upper Calciferous formation and the Lévis conglomerates; and as we have seen, from the statements and comparisons just made, that the conglomerates of Lévis, Stanbridge and Cow Head, in Newfoundland, are all of the same horizon, we must infer that those of Lévis, together with the associated graptolitic shales, are superior at least to the Upper Calciferous limestone of the Philipsburg series.

Further comparisons between Lévis and Philipsburg.

In support of the views just expressed, the paper by Billings (see *Canadian Naturalist*, 1861, vol. vi, p. 310), "on some of the Rocks and Fossils occurring near Philipsburg, C.E.," may be cited. These rocks are there divided into two series, "1st, Magnesian Limestone and Underlying Slate; 2nd, Blue thin-bedded and nodular limestone. The first division which constitutes the lower beds of the series, is found along the eastern side of Missisquoi Bay, and consists of "magnesian limestone, often arenaceous" and with quartz veins, interstratified with nearly pure limestone; also limited areas and lenticular masses of hard white or

Rocks of the Philipsburg, views of Billings.

yellowish-white sandstone, intercalated with the limestone. The thickness of the series is estimated to be not much less than 400 feet. Succeeding these are the thin-bedded, dark-colored limestones of No. 2, in which have been found about forty species of fossils which show this part of the limestone series to be the equivalent of the upper part of the Calciferous sand rock. On p. 315 *ibid.* he shows that the fossils from division, No. 2 agree very closely with those from the limestone No. 2 of Lévis, and establishes by this fact that the general aspect of the whole of the fossils from the two localities is the same, while at least one-half of the speices are common to both, and then states clearly that "he holds limestone No. 2 of Philipsburg to be the equivalent of limestone No. 2 of Lévis. This statement would undoubtedly hold good were the Lévis fossils obtained from the matrix of the rock. But in *Canadian Naturalist*, 1860, vol. v, p. 301-02, in enumerating the fossils from the Lévis limestone, he says: "All the specimens described in this article were found in the conglomerate limestones near Point Lévis, opposite Quebec. It is not yet decided whether the fossils occur in the boulders of the conglomerate or in the matrix."

Philipsburg conglomerates of same horizon as those of Lévis.

That these fossils are, however, in many cases at least, clearly in the pebbles as distinct from the paste of the conglomerates is evident, and it is from this apparent neglect to distinguish between the limestone proper and the limestone pebbles of the conglomerate that much of the confusion and uncertainty appears to have arisen. This is also, to some extent, doubtless due to the early statement of Sir Wm. Logan, in Can. Nat., 1860, vol. v, p. 472, that he had satisfied himself, "notwithstanding the conglomerate aspect of the bands of rock which contain our new fossils, that the fossils are of the age of the strata."

Fossils from the pebbles of the Lévis conglomerates.

It must be remembered, however, that the problem was not even then considered as conclusively solved, and subsequent researches have shewn that some at least of the fossils found at Lévis in the pebbles of the conglomerate are of the age of the Upper Calciferous limestones, from the débris of which the conglomerate are partly made up. This fact therefore must of necessity assign both the Stanbridge and the Lévis rocks to a later period.

Such, in brief, is the history of this interesting group of rocks down to the year 1868. In the meantime, Mr. A. Murray had assumed control of the Geological Survey of Newfoundland and had begun the systematic study of the rocks of the same group as developed in that colony which were first studied by Jas. Richardson in 1860-62.

Geol. Sur. of Newfoundland, 1864.

In the reports of the Newfoundland Survey, 1864, pp. 49-50, Sir Wm. Logan presents in tabular form the relative position of the several members of the Quebec group as then understood, in which he places it above the Upper Calciferous and intermediate between that forma-

tion and the Chazy. The division of the group into three parts was given, of which the Lévis was regarded as the lowest and held to comprise the limestones, and black shales of Point Lévis, Orleans Island and Philipsburg, containing graptolites, trilobites, etc., which were, for the most part, identical with the Skiddaw slates. The second or Lauzon, once a part of the preceding, but now separated from it on account of its great mineralogical importance, was distinguished as the metalliferous zone of the Lower Silurian of North America. It embraced magnesian rocks, such as dolomites, magnesites, serpentines, diorites, chloritic and steatitic beds, with micaceous and gneissic strata and rich cupriferous slates, with gold and silver, nickel and chromium. It yielded only two fossils, an *Obolella* and two *Lingulæ*, and was overlaid by 2000 feet of sandstone and conglomerate, interstratified with green and red shales, which constituted the Sillery formation, but was apparently destitute of fossils. The opinion is again expressed that over a large part of its distribution the Quebec group is crystalline and metamorphic, and the characteristic minerals are found in both the altered and unaltered portions. Views of structure held by Sir Wm. Logan, 1864.

In Mr. Murray's Report, 1873, page 336, the opinion of Mr. Billings, 1863, as to the age of certain fossils sent from Newfoundland is quoted thus: "These rocks are the upper part of the true Calciferous, and lie next below the Lévis formation, comparing them to divisions H, I, K, L, M, of the table on p. 879, Geol. Can., 1863, while the succeeding fossiliferous limestone conglomerates, limestones and shales of the Levis are regarded as divisions N, O and P of the same table. Geol. Surv., Newfoundland, 1873. Structure of the Quebec group. A. Murray.

It will be seen from all the evidence adduced from so many sources that the true position of the Lévis was very conclusively established both on palæontological and stratigraphical grounds as distinctly newer than the Calciferous, and this conclusion has been sustained by the most recent examination.

In 1868, Mr. Jas. Richardson, assisted by Mr. McOuat, began anew the study of the formations along the south side of the St. Lawrence, in the area comprised between that river and the boundary of the state of Maine, and extending from the Chaudière River on the west to the Temiscouta road which crosses the country southward from River du Loup to Temiscouata Lake. The result of this work appeared in the Report of Progress for 1869, accompanied by a map, in which the various formations there found are grouped on an entirely new plan, and supposed to extend from the base of the Potsdam to the Upper Silurian, both inclusive, the former of which was now made to include much of what had hitherto been regarded as belonging to the Quebec group. This was divided into three portions, a lower, middle and upper. The results of this exploration were briefly summed up by J. Richardson, 1868-69. New views of structure.

Sir Wm. Logan in his introductory report for 1869. In this report, the central axis, since found to be the extension of the Sutton Mountain anticlinal, is still described as a synclinal in the Sillery, following the old view of the structure of this range, and extending along the middle of the area "with a breadth of from two to twelve miles, affected by several minor undulations, and presenting a ridge of broken country, much covered by forest and little fitted for purposes of agriculture." On the south-east side of this ridge, the Lauzon was supposed to emerge, having a breadth of one to six miles and was followed by the black shales and limestones of the Lévis formation, which in turn were overlapped to the south-east by what was regarded as the Upper Silurian area of the Eastern Townships, but which is now known and described as of Cambro-Silurian age. The structure between this central ridge and the St. Lawrence is thus described: "On the north-west side, the Sillery is followed by the Lauzon only, in circumscribed and isolated portions, without the Lévis formation; the Sillery being in contact for a great part of its distance with what is now supposed to be a lower and unconformable series of rocks. Like the rocks of the Quebec group this lower series consists of red and black shales, limestones, sandstones and conglomerates, having an arenaceous base and limestone pebbles. It was formerly classed as belonging to that group, and it is only on the evidence of its fossils that it can be placed in a lower horizon. Some of these fossils are of known primordial species, and all have, in the opinion of Mr. Billings, an undoubted primordial aspect, but the manner in which they occur does not at once produce a satisfactory conviction that they determine the age of the deposits. The fossils, with but few exceptions, are in the pebbles of the conglomerates, which though derived from the destruction of primordial rocks may not possibly lie in such now. The series seem almost to stand in place of the Lévis, but the want of conformity shewn by the contact with the Sillery, and the occurrence of a *Salterella* in an even-bedded limestone would seem to carry the preponderance of evidence the other way. Provisionally, this series will be considered primordial, and as belonging to the upper part of the Potsdam. It consists, in ascending order, of the following divisions :—

Structure south side of the St. Lawrence.

Supposed areas of Potsdam rocks.

1. Red and green shales, surmounted by even-bedded grey limestones, in which a species of *Salterella* occurs, with black phosphatic nodules.
2. Grey sandstone, with black shales interstratified with conglomerates, having a calcareo-arenaceous cement, and holding limestone pebbles, with occasional black phosphatic nodules. The limestone pebbles hold fossils of primordial type.

3. Grey, quartzose sandstones, passing into quartzite, which are often of a conglomerate character, with limestone pebbles, holding fossils like those of the previous division. The beds are occasionally interstratified with black shales.

These deposits present themselves between the Sillery ridge and the St. Lawrence, in a belt of country extending the whole distance examined, with a breadth in one part of twelve miles. In this they are arranged in two main synclinal forms with many minute undulations, and they are overlaid uncomformably by two long synclinals of the Lauzon and Sillery, one of them with a stretch of sixty miles."

The above are the latest views published by the Geological Survey as to the age and structure of the rocks of this group, prior to the report of Dr. Selwyn in Rep. Prog., 1877-78, pp. 3A-9A. It is evident that much of the confusion which has arisen as to the correct interpretation of the geological structure of south-eastern Quebec is due to the opinion expressed in the first years of its study, viz., that the rocks of the Sutton Mountain range and of its extension to the north-east were arranged in synclinal instead of anticlinal form. This error in turn doubtless arose from the confounding of several distinct formations of sandstones and quartzites in one general group, subsequently styled the Sillery, a mistake first pointed out by Dr. Selwyn in the report just alluded to. Another source of error, and possibly the most considerable, was the assumption that the metamorphic rocks of that area must of necessity be the equivalents of the unaltered sediments of the St. Lawrence region, a theory which once suggested, seems to have been unhesitatingly maintained, although for its support, unnecessary inversions of strata, and profound chemical changes were requisite. That there is no marked lithological resemblance between the schists and other crystalline rocks of the central anticlinal and the ordinary sediments of the Lévis, Lauzon and Sillery, is a fact patent to any one who has ever studied the geology of the two areas.

New views of structure by Dr. Selwyn, 1877-78.

The new views of structure regarding the rocks of the Quebec group, put forth by Dr. Selwyn in the Rep. Prog., 1877-78, may be here briefly noted, owing to the great importance of the changes there made in the stratigraphical relations of the original divisions of that group. Three distinct series were recognized in descending order, as follows

"1. Lower Silurian, held to represent the comparatively unaltered and fossiliferous portion.

2. The Volcanic Group, probably Lower Cambrian, including the coarse, thick-bedded, felspathic, chloritic and quartzose sandstones, and siliceous shales of various colors, differing much in character from the more shaly though often similarly colored sediments of the first division, with dioritic and serpentinous rocks, crystalline dolomites, etc.

Cambrian and probably Pre-Cambrian first recognized.

3. The Crystalline Schist Group (Huronian ?), embracing the chloritic, micaceous, siliceous and other schists, also imperfect gneisses, white and grey crystalline, micaceous dolomites, and magnesian limestones, which constitute the main anticlinal of the region, and can be traced north-east through Sutton Mountain to the rear of Point Lévis."

In addition to the pointing out of the mistake which had for so long been made in the grouping of so many widely differing horizons of sandstone and quartzite in the Sillery formation as the upper portion of the Quebec group, the opinion was expressed (page 4A) that no sufficient evidence existed of any kind for the separation of the Potsdam areas indicated in the Report 1869, although the possibility of the occurrence of rocks of that age in the great mass of the fossiliferous series was admitted. In this Report the direction of the principal fault by which the Utica beds of the north side of the Island of Orleans are brought against the Lévis shales and conglomerates, and which had hitherto been held to pass in rear of the Citadel of Quebec, was changed to pass in front of the city and to reach the north side of the St. Lawrence, about one mile north of Point à Pizeau at Wolfe's Cove. The correctness of this view has since been clearly established by the finding of fossils in the city of Quebec, not only in the Cove Fields and in front of the new Parliament Buildings, but also in the cliffs bordering Champlain street, along the side of the River St. Lawrence, all of which present forms similar to those found in the rocks along the north-west side of the Island of Orleans and indicate, doubtless, a similar horizon.

Position of the great fault changed to rear of Citadel in Quebec.

The lithological aspect of the strata at Quebec and Point Lévis also shows the probable difference in the age of the rocks on either side of the river, since, while the beds which make up the cliffs of Cape Diamond, and for some distance up the river from that point, as well as those seen in excavations along the Cape Rouge Road, in rear of Spencer Wood, present the usual aspect of the black bituminous shales, with their peculiar fauna of graptolites of Utica-Trenton types. The characteristic red and green shales which form the cliffs at Point Lévis are seen to reach the west shore of the river at the depression of Wolfe's Cove, where they rest upon the newer bituminous shales and limestones, the contact being evidently due to a profound fault by which the highly graptolitic beds and associated limestone conglomerates, seen along the line of the Intercolonial Railway, below the lower ferry, are cut off before reaching the shore above Cape Diamond. In the red beds and associated strata at Point a Pizeau, which constitute the cliff in front of the church at that place, *Obolella pretiosa* occurs, a form precisely similar to that found at the Chaudière Railway bridge, as well as at the falls below, on that stream.

Difference in character of the rock along shore above Quebec

Fault at Wolfe's Cove.

Fault at Ste. Foye.

The line of this fault to the west of the point where it reaches the shore at Wolfe's Cove is indicated by Dr. Selwyn as passing to the north of Ste. Foye and thence south-westerly to the river again, where it crosses above Cape Rouge. This point may be said to be about two miles above the Cape, whence crossing to the south side of the river the contact is seen in the cliffs, about two miles south of the mouth of the River Rouert, and not far from the church of St. Nicholas. Thence it extends south-westerly in the direction of Lake Champlain to Missisquoi Bay.

Prof. Lapworth, 1886.

In many respects the most important paper relating to the fossils of this group is that by Prof. Lapworth, published in the Transactions of the Royal of Society Canada, for 1886. This paper embodies the results of the examination of a large suite of specimens, mostly graptolites, collected along the shores of the St. Lawrence at various points from Point Lévis to Cape Rosier by Mr. T. C. Weston, but including also a few labelled from the vicinity of Cape Rouge, collected by Mr. Billings, and certain poorly preserved specimens from Cape Breton by Mr. Fletcher. The graptolites have been arranged by Prof. Lapworth into three zones and one sub-zone as follows:

Zone I. Cape Rosier Zone.—Zone of *Dictyonema sociale* and *Bryograptus*.

Zone II. Ste. Anne Zone.—Zone of *Phyllograptus Anna*. Graptolites from the rocks three miles above Ste. Anne.

Zone III. Griffin Point or Marsouin River Zone.—Zone of *Cœnograptus gracilis* including

Sub-Zone III A.—Rocks of the Cove fields and St. John's Market, Quebec, and the north side of the Island of Orleans.

Graptolite zone I., presumably Cambrian.

Of these the first is considered to represent the oldest or to be of the horizon of the Cambrian, principally from the presence of *Dictyonema sociale*, a *Clonograptus* and a *Dichograptus*, two of which are regarded as new species. This *Dictyonema* has not, in so far as is yet known, been figured from the Point Levis beds, the most westerly point from which it is reported being Matane.

Zone II base of Cambro-Silurian.

Zone II is regarded by Prof. Lapworth as newer than the preceding by a well marked interval, and as much older than Zone III. None of its species are common to the other zones, so far as known, nor are they known to European equivalents of these zones. The species determined, which are principally from Ste. Anne des Monts, are all well known Point Lévis species, according to Prof. Hall, and pertain to the corresponding Arenig-Skiddaw of the English Survey.

Zone III.

The third zone is also distinguished apparently by a fauna peculiarly its own, "the presence of a single one of which is sufficient to settle the age of the rocks in Great Britain, and in all likelihood in America."

The rocks of this zone have been long regarded by the Geological Survey as belonging to the horizon of the Utica or Hudson River, and are so described in earlier reports. This view was derived from the similiarity of the contained graptolites to those found on the Hudson River, at Norman's Kill, which was first pointed out by Prof. Jas. Hall, to which position the New York geologists have always assigned the strata of that place. Prof. Lapworth holds that while there is no doubt that the fossils found in the rocks of Zone III belong to the second Ordovician or Cambro-Silurian fauna, they are newer than the graptolitic strata of Point Lévis, that is, they belong to the Trenton-Utica instead of the Calciferous-Chazy fauna on the one hand, or of the Utica-Hudson on the other.

Zone III. presumably Trenton-Utica.

The position of Zone III, the equivalent of the Norman's Kill rocks, is, according to Lapworth, about the middle of the Llandeilo formation, above the Arenig and below the Caradoc, or in Canadian geology, about midway between the base of the Point Lévis phyllograptus beds and the summit of the Loraine or Hudson River group.

Sub-zone A.

The position of the Sub-zone A appears to be difficult to decide. Prof. Lapworth says "the specimens are all of Llandeilo-Bala age and the general facies indicates a horizon about the summit of the Cœnograptus or Marsouin beds zone." He says, "the association of forms reminds me of that of the highest Glenkiln or lowest Hartfell beds of the south of Scotland. I should imagine that they follow on at once upon the Cœnograptus beds without a break. Indeed, it is possible that *Cœnograptus* may be detected among them,* but, judging from the British phenomena, this is doubtful. It is not unlikely that these Cove-field beds mark the transition from the Marsouin beds into the lowest zone of the Black River and Trenton limestone. The presence of a form identical with or closely allied to the *G. amplexicaulis* of Hall, points in this direction."

"There is nothing in the Cove-fields or St. John's market fauna that reminds us in the slightest degree of the fauna of Point Lévis. The fossils are the fossils of the Marsouin River fauna or second Ordovician fauna, and have not a species in common with the first Ordovician fauna—the typical fauna of Point Lévis."

Prof. Lapworth summarizes the results of his investigations on the fossils from the various localities as follows:

Conclusions of Prof. Lapworth as to the horizons of the graptolites.

"1. The graptolites of the collections examined are all derived from rocks of greater antiquity than the so-called Utica and Hudson River rocks, if we regard these as typified by the fauna hitherto described from the graptolitic rocks of Lake St. John, Canada, and those of the Valley of the Mohawk, in the State of New York.

* Found by Mr. Ami in 1888 on the north-west side of the Island of Orleans.

2. There are two grand faunas represented in the collection, viz.: Two grand faunas represented.

A. The so-called Quebec fauna of the Calciferous-Chazy formations of Cape Breton, Cape Rosier, Point Lévis and Ste. Anne, which answers to the fauna of the British Upper Tremadoc and Arenig rocks and their European equivalents.

B. The Griffin Cove, Marsouin River and Norman's Kill fauna, which answers to the faunas of the middle zones of the European Ordovician or Cambro-Silurian rocks.

3. In each of these grand faunas are found two sub-faunas, those of the lower fauna being the most distinctly separable. Two sub-faunas.

A. Quebec or Calciferous-Chazy fauna:—

Sub-fauna 1. Cape Rosier, and Barasois River zone of Calciferous age. Tremadoc rocks of Great Britain, and *Ceratopyge* and *Dictyonema* beds of Norway.

Sub-fauna 2. The Ste. Anne River Zone of Point Lévis age, typical Arenig of Great Britain. *Phyllograptus* beds of Scandinavia.

B. Trentonian, Marsouin River or Norman's Kill Fauna:—

Sub-fauna 1. The Cœnograptus Zone of Griffin's Cove and the Marsouin River, answering to the Middle Llandeilo beds of Great Britain and the Glenkiln beds of Scotland, etc.

Sub-fauna 2. The Cove-fields and Island of Orleans sub-fauna. Apparently destitute of *Cœnograptus gracilis*, and answering to the highest Llandeilo or lowest Caradoc beds of England.

4. The last of these sub-faunas shews evidence of transition into the Utica-Loraine graptolitic fauna of the Mohawk Valley, New York and of Lake St. John, Canada."

Concerning the position of the upper division, formerly the Hudson River and Utica of Logan and Hall, Prof. Lapworth says:—"It appears at present that we are destitute of any clear evidence that true Utica and Hudson River strata occur anywhere along the south side of the St. Lawrence from Gaspé to Quebec, all the strata seeming to be older in point of time than the Utica proper, as typified by the rocks of the Ottawa and Lake St. John. As to the two formations of the Trenton and Utica, being mapped in New York and Western Canada essentially on lithological grounds, it is exceedingly probable that the line between them differs greatly in true geological age, when followed from Quebec to Ottawa and New York; so that in some localities, where the Trenton limestone series is poorly developed, the Utica of that locality actually descends to and includes the Norman's Kill and Marsouin Zone. But this is a fact for future investigation. The facts as they stand, relate Lapworth's conclusions as to the upper divisions formerly supposed to be Hudson River or Utica.

the Marsouin and graptolitic shales to the Trenton, rather than to the Utica slates, as at present understood."*

Quebec City rocks.

"The so-called Quebec rocks, of the town of Quebec, as typified by the fossils forwarded from the Cove fields and St. John's Market, are not of Quebec age at all. They are probably the newest rocks represented in the collection, and possibly shade upwards from the Marsouin graptolitic shales of Orleans Island and Cape Rouge.† They appear, however, to be of greater antiquity than the Utica shales of Lake St. John, answering to the basement zone of the British Bala, instead of to the middle zone, which seems to be the place of the Lake St. John shales."

General conclusions.

From a careful consideration of all the facts presented in the valuable paper of Prof. Lapworth, it is evident that in the main the Geological position of the associated rocks, as constituting a lower portion of the Cambro-Silurian system given in the preceding pages, from both the stratigraphical and palæontological evidence, is clearly maintained by the latest determination of the graptolitic fauna, with the possible exception of the lowest or *Dictyonema* zone, which from the presence of three species only is considered by Prof. Lapworth to belong to a lower formation. Of these species, two, a *Clonograptus* and a *Dichograptus*, are apparently new, and as yet undetermined, and their occurrence need not therefore be considered conclusive as determining exact zones. The presence of *Dictyonema* appears, then, to be the only reason why those portions in which this form is known to occur, otherwise intimately associated with strata holding Cambro-Silurian fossils, and which have so long been regarded as belonging to that group, should be removed from their apparently proper position in the series and placed in a different geological system; and in view of the wide range *Dictyonema* is known to possess, we may well hesitate before deciding upon such a separation, unless confirmatory stratigraphical evidence can be presented.

Distribution of the unaltered Quebec group rocks.

The rocks which have been described above, as belonging to the unaltered Quebec group, form a belt along the south side of the St. Lawrence, having a breadth of from twelve to twenty-five miles. Their characters have been given with great fulness in the reports already reviewed.

Work of the past two seasons.

During the past two seasons, but more especially in 1888, much time has been devoted to a systematic study of the several divi-

* All the stratigraphical evidence shows that the beds in question are above the Trenton limestone. They probably represent a downward development and great thickening out of the Utica proper of Lake St. John, Ottawa and New York.—A. R. C. S.

† In regard to the fossils from bituminous shales said to be from Cape Rouge, there is probably some mistake in the labelling of the specimens, the rocks of that place being the oldest of the fossiliferous Q. G. series.—R. W. E.

sions of the group and its contained fossils, more particularly in the vicinity of the St. Lawrence River, where magnificent sections are afforded along the south shore, as well as on the group of islands lying midway in the channel. Of all of these, and of the main shore, carefully paced surveys were made as far as the River Ouelle. These surveys have now been plotted to a uniform scale of twenty chains to the inch, as it was found that on any smaller scale the many complicated folds and faults which everywhere affect these rocks could not be indicated. The object of these surveys was to determine, if possible, the true relative positions of the Lévis and Sillery conglomerates, sandstones and shales, the results of which may now be given in some detail. Coast surveys.

In the vicinity of Lévis, St. Joseph, and on the extreme south-west end of Orleans Island, the series of shales, black, green and grey, with hard, generally thin bands of yellow weathering, dolomitic limestone, and beds of greyish limestone conglomerate, usually known as the Lévis formation, is well exposed. The slates are generally easily recognized on smoothed weathered surfaces, from their usually greenish shade striped with black, and in certain portions, more particularly the black bands, they are thickly covered with impressions of graptolites and other fossils as lingulæ, discinæ, etc. These peculiar rocks, while occasionally seen at other points, have not apparently a wide distribution along the coast or adjacent country between Levis and River du Loup, at which place our examinations during the past season ended. The beds of limestone conglomerate which are associated with these are generally thin, and frequently occur as lenticular and often local masses, thinning out rapidly at either extremity. About Lévis these conglomerates occur in a series of outcrops between the river front and the road to the south-east of the forts, about one mile and a-half distant, and their distribution and synclinal arrangement have been very clearly indicated by Sir Wm. Logan in the atlas accompanying the Geology of Canada, 1863. Since that time, however, the building of the Lévis forts has disclosed outcrops, at that date concealed, some of which have been found to be richly fossiliferous, and these have thrown additional light upon the vexed question of the structure and relative position of the various beds in this area. Rocks of Lévis and vicinity. Limestone conglomerates.

In the section accompanying the map of the distribution of the limestone conglomerates at Lévis, just referred to, the series of anticlinals which occur on the line of section between the river and the middle fort, is indicated. Four well defined axes can be recognized in this distance, two of which at least are completely overturned. Of these the most easily recognized is that along the cliff which fronts or overhangs the road between the Victoria hotel at Point Lévis and St. Four anticlinals at Lévis.

First anticlinal.

Joseph. On the road going up this cliff, along the stone wall, about 300 yards south of the lower ferry, the overturned arch of this fold is clearly seen near the sharp bend at the top. Above this, toward Point Lévis, the same overturned and at times crushed beds, which indicate the crest of the anticlinal, are also well exposed; these beds along the road, near the toll-gate, have yielded a considerable variety of forms, among which the following are easily recognized:—*

RHABDOPHORA.

Fossils from below Victoria Hotel, Point Lévis.

1. *Diplograptus tricornis*, Carruthers.
2. " sp.
3. " *folium*, Hisinger (as of Nicholson).
4. *Glossograptus ciliatus*, Emmons.
5. " sp. indt.
6. *Trigonograptus ensiformis*, Hall.
7. *Clonograptus rigidus ?* Hall.
8. *Climacograptus*, sp. indt
9. " *scalaris*, Hisinger.
10. *Nemagraptus*, sp.
11. *Dichograptus ? ramulus*, Hall.

BRACHIOPODA.

12. *Orthis*, Sp. allied to *O. Hippolyte*, Billings.

A short distance below the Victoria Hotel, in the black and green shales overlying the red, were found:—

1. *Phyllograptus typus*, Hall.
2. *Dichograptus*, sp.
3. *Tetragraptus brachiatus*, Hall.
4. *Didymograptus constrictus*, Hall.
5. *Dawsonia*, sp.

From conglomerate band west of the toll gate were obtained:—

1. *Crinoidal columns*.
2. *Leptæna decipiens*, Billings.
3. *Euomphalus*, sp.

Lowest Lévis zone.

The fossils above enumerated were obtained partly from the limestone bands and partly from the black and green shales, and should properly represent the lowest portion of the Levis formation as dis-

* These fossils have been examined and determined by Mr. H. M. Ami.—R. W. E.

tinguished from the Sillery, since directly underlying them are the red and green Obolella shales which form the anticlinal near the Victoria hotel, and with which are associated the beds of Sillery sandstone. These red shales, in rear of the hotel have also yielded graptolites, but owing to the crushed nature of the beds, the former are badly preserved and much distorted, and have not yet been determined. *Obolella pretiosa* is also found here.

From the Victoria hotel, the road going up the steep hill in the rear to the south-east passes over these red and green shales, and a short distance beyond the most westerly of the three Lévis forts, the peculiar grit and sandstone known as the "Sillery sandstone" occur in several well-defined ridges extending eastward at intervals for about three miles, and separated from each other by beds of red and green and sometimes black or grey shales. The character of these sandstones has already been given, and they sometimes pass into a fine conglomerate made up for the most part of pebbles of quartz with pieces of shale. These different kinds of rock are well seen in the quarries to the south-east of Point Lévis. Tracing these outcrops of siliceous rock they are found to be, in every case observed, lenticular masses, sometimes very limited in extent, but occasionally of very considerable area, enclosed in the red shales in the same way as on the west side of the river at the Sillery quarries. It is plain, therefore, that the Sillery sandstones and associated red shales are part of the same formation. Now, if we examine the series of anticlinals which occur between the lower ferry of Lévis and the middle fort we find these red shales cropping out in nearly or quite every case where the anticlinals occur, and dividing the synclinal areas which hold the graptolitic shales and associated limestone conglomerates, thus clearly indicating the lower position of the red shale series. In order to prove conclusively the synclinal structure of the Lévis graptolitic shales, carefully located collections of fossils were made at various points, more particularly along a line of section between the Intercolonial Railway and fort No. 2, from which the following results have been derived.

Rocks south-east of Point Lévis.

Association of Sillery sandstones with red shales.

A "Tetragraptus zone" is seen in a cutting on the Intercolonial Railway 1600 paces below the lower ferry or I. C. R. station. These overlie a thin band of limestone conglomerate and are in turn overlaid by a heavy band of the same, the paste of which is highly siliceous and in places almost a quartzite with scattered pebbles of limestone: a short distance further west, these shales and conglomerates are underlaid by heavy beds of hard Sillery-like sandstone and grit. The fossils in this cutting are abundant and the zone is one of the lowest in the Lévis series. Among the species collected the following have been definitely recognized:—

Intercolonial Railway cutting below Lévis.

Fossils.

1. *Dichograptus octobrachiatus*, Hall.
2. " *Richardsoni*, "
3. *Goniograptus Thureaui ?* McCoy, or n. sp.
4. *Tetragraptus serra*, *Brongt.* (= *T. bryonoides*, Hall.)
5. " *quadribrachiatus*, Hall.
6. " *approximatus*, Nicholson.
7. " *fruticosus ?* Hall.
8. *Clonograptus flexilis*, Hall.
9. *Phyllograptus typus*, Hall.
10. *Lingula Irene*, Hall.

The beds of shale from which the above fossils were obtained occur on the northern side of the most westerly synclinal in the Lévis rocks. Passing southward along the line of railway about 700 yards, an offset of eighty paces to the south-east, brings one to the steep pitch and curve in the road from Lévis to St. Joseph. Here, in the cliff just to the right of the main road, looking down the river, are highly fossiliferous black and green slates which lie on the east side of the overturned synclinal basin along the centre of which the road to St. Joseph extends. The similarity of these beds to those just described will be evident from the accompanying list of forms there obtained; the zone may, for the sake of reference, be styled the "Didymograptus zone":—

Road from Lévis to St. Joseph.

Fossils.

1. *Didymograptus bifidus*, Hall.
2. " *extensus*, Hall.
3. " *furcillatus*, Hall.
4. " *pennatulus*, Hall.
5. *Tetragraptus Bigsbyi*, Hall.
6. " *fruticosus*, Hall.
7. " *serra*, Brongt.
8. *Phyllograptus typus*, Hall.
9. *Clonograptus*, sp.
10. *Dictyonema*, n. sp. (allied to *D. delicatulum* Dn., preoccupied.)
11. *Lingula Irene*, Billings.
12. " *Quebecensis*, Billings.
13. *? Siphonotreta micula*, McCoy.

On the continuation of this cliff, one hundred and fifty yards to the west, the following were obtained:

1. *Dendrograptus*, sp.
2. *Dictyograptus*, cf. *D. Homfrayi.*
3. *Tetragraptus serra*, Brongt.
4. *Lingula*, allied to *L. Quebecensis.*

5. *Linnarssonia*, sp.
6. *Lingula*, sp.
7. *Shumardia granulosa*.

Further west, in front of Carriere & Laine's foundry, a further collection was made as follows: Fossils from cliff facing the foundry, Lévis.

1. *Tetragraptus quadribrachiatus*, Hall.
2. " *Bigsbyi*, Hall.
3. " *serra*, Brongt. (= *T. bryonoides*.)
4. *Diplograptus dentatus*, Brongt. (= *D. pristiniformis*, Hall.)
5. *Dictyograptus*, n. sp.
6. " *irregularis* ? Hall.
7. *Dictyonema delicatula* ? Dn. sp. (Species preoccupied 1881, Lapworth.)
8. *Nemagraptus capillaris*.
9. *Leptobolus* ? n. sp.
10. *Lingula*, n. sp.
11. *Orthis*, sp.
12. *Lingula Quebecensis*, Billings.
13. " *Irene*, Billings.
14. *Shumardia granulosa*, Billings.

Ascending the cliff near this point by a flight of steps, a band of red shales is seen near the brow of the hill. To the east, on the summit of the cliff, above the other localities, thin bands of limestone conglomerate occur and the crest of the first anticlinal passes through this point. Continuing the section towards the front street in the city of Lévis a series of greenish-grey shales, striped with black, is passed over, which extends to the city hall. Here excavations have been made in beds of shales associated with limestone conglomerate, many of which are thickly studded with graptolites, among which were determined: Fossils from City Hall, Lévis.

1. *Didymograptus extensus*, Hall.
2. do *pennatulus*, Hall ? (= *D. Murchisoni*, Carr.)
3. do *bifidus*, Hall.
4. *Tetragraptus serra, Brongt.* (=*T. bryonoides*. Hall.)
5. do *Bigsbyi*, Hall.
6. do *fruticosus*, Hall.
7. do *denticulatus*, Hall.
8. *Dichograptus octobrachiatus*, Hall.
9. do (?) *Richardsoni*, Hall.
10. *Phyllograptus typus*, Hall.
11. *Lingula Quebecensis*, Billings.

From the pebbles of the associated limestone conglomerates were obtained Crinoidal columns, *Orthis*, sp. *Salterella*, sp. *Illænus*, sp.
From the shales associated with the limestone conglomerates of the middle fort were obtained :—

1. *Phyllograptus typus*, Hall.
2. " *angustifolius*, Hall.

and from the associated greyish and black shales,
Lingula Quebecensis, Billings.

Positions of the several anticlinals at Lévis.

The axis of the second anticlinal in this section is in the town of Lévis about a fourth of a mile back from the edge of the cliff on the road up from above the lower ferry, the opposing dips being clearly seen and the underlying red Sillery shales showing in the streets. The axis of this should cross the road from the city hall to fort No. 2, near the Catholic church. Limestone conglomerates again occur on this road, ten chains south-east from the main back road in Lévis and rest on both sides upon the red slates; this marks presumably the crest of the third anticlinal. The fourth occurs near the corner of the road a short distance west of the fort No. 2, where hard gritty beds with red and green shales are exposed overlaid on the eastern side by the usual Lévis black and striped grey shales and limestone conglomerates in thin bands, the synclinal structure of which, and their overlying position in regard to the red slates, can be well seen in the trench along the east side of the embankment which connects the different forts. Thence to the east of fort No. 2 the limestone conglomerates and fossiliferous shales are well exposed in low ridges, the structure of this portion to the St. Henry road being doubtless an overturned synclinal, since on that road just beyond the toll gate the red shales and sandstones of the Sillery again occur.

Lévis shales and conglomerates overlie the Sillery.

The general dip of most of the beds in this line of section is to the south east, and at first glance the series would appear to be a regularly ascending one. At several points, however, the overturned position of the beds is very evident and thus gives a key to what we believe to be the true structure as indicated above. That the limestone conglomerates and associated shales occur in synclinals is very clear from the section exposed in the cutting in the Intercolonial Railway at St. Joseph station where the northern end of a synclinal is cut directly across.

Sir Wm. Logan's section

The anticlinal structure of the greater part of this section is well shewn on the map of Lévis, published by Sir W. Logan in 1866, though the overturned synclinal in the eastern portion is not there indicated, the red shales being represented as coming in upon the Lévis conglomerates and fossiliferous shales in the upper portion of the group.

The fossils above described, while apparently not very greatly differing in their horizon, may be all regarded as pertaining to the Lévis formation, the lowest division being that found just below the Victoria hotel where the relationship to the red shales of the upper part of the Sillery is very close. On the shore below St. Joseph are several localities from which fossils were obtained, of which the lowest is very similar to that near the Victoria hotel. This is on the west side of the cove where the brook which crosses the I.C.R. at Harlaka Junction enters the St. Lawrence about one mile and a half north-east of that place. Here the graptolites occur in a band of black and green shales in places irony and interstratified with red and green shales of the upper Sillery, and contain, besides the graptolites, *Obolella pretiosa*, the same as found in the shales of Point Lévis and at Point a Pizeau. These presumably represent the lowest zone of graptolites in the Pointe Lévis section. The species determined are:— Shore below St. Joseph. Fossils.

1. *Tetragraptus serra*, Brongniart.
2. *Didymograptus extensus*, Hall.
3. *Obolella*, prob. *O. pretiosa*.
4. " sp.

On the shore, half a mile to the west, certain bands of black and greyish dolomitic shales with green and brown slates are thickly studded with graptolites, among which are:—

1. *Phyllograptus angustifolius*, Hall.
2. *Tetragraptus serra*, Brongniart.
3. " *approximatus*, Nicholson.
4. " *Bigsbyi*, Hall.
5. " *quadribrachiatus*, Hall.
6. " *Hicksi*, Lapworth.
7. *Didymograptus*, allied to *D. furcillatus*, Lapworth.

In the cutting in the snowshed on the Intercolonial Railway, half a mile west of Harlaka junction, a series of red, green, black and brown shales occur, the red portion of which is evidently of upper Sillery age, since they contain enclosed beds of Sillery sandstone a short distance to the south-west. They also hold fossils, from which a cursory examination revealed the presence of:— Snow-shed cutting west of Harlaka Junction.

1. *Lingula Quebecensis*, Billings.
2. *Phyllograptus typus*, Hall, with other forms.
3. *Tetragraptus serra*, Brongniart.

The foregoing lists of fossils from various points will give a fair idea of the fauna of the typical Lévis rocks. Other collections were made from the interstratified beds of conglomerates, but as these were in all cases from the limestone pebbles, and not from the matrix, their value in determining exact horizons from these rocks is doubtful. It may, however, be said that while several of the former, more especially of the trilobites, have a Cambrian aspect, many of the others have a distinctly Cambro-Silurian character, and in some of the pebbles, graptolites of the kind found in the lower zone from the Intercolonial Railway cutting were obtained. The forms obtained from the pebbles in the various bands of conglomerate will be enumerated in a subsequent page.

Character of the fossils from pebbles in the limestone conglomerates.

The red shales and Sillery sandstone series, which are now held to underlie the fossiliferous Lévis rocks just described, first appear at the Victoria hotel, which point may be taken as forming their most northerly limit along the south side of the St. Lawrence, in the vicinity of Lévis at least, since to the northward they are almost entirely and directly overlaid by the Lévis shales and conglomerates; but on the roads going south-east toward St. Henry, of which there are two, one straight out past fort No. 2, and the other following up the valley of the Etchemin, the Sillery rocks are well displayed. For a space of nearly four miles, ridges of sandstone and grit form prominent features in the landscape, and break the otherwise monotonous character of the flat country between Lévis and St. Henry. On the Etchemin River these areas of sandstone first commence one mile below the Intercolonial Railway bridge. To the west of Lévis the red shales form conspicuous cliffs in the direction of Hadlow, near which place the interstratified beds of sandstone come to the railway. Thence toward Chaudière junction, along the line of the Intercolonial, formerly the Grand Trunk, alternations of red, green and black shale, with areas of sandstone, occur, to within one mile and a-half of that point, or almost to the railway branch crossing to Breakey's mill. All these beds along the railway have a very regular dip to the south $< 35°$ $60°$. Beyond this place the country is covered by clay to the junction, where a small cutting in black and green shales shows the presence of *Obolella*. Along the south side of the St. Lawrence the ridges of Sillery sandstone continue to the mouth of the Chaudière, having a breadth southward on that stream of one and three-fourths of a mile, or to the Grand Falls below the Grand Trunk Railway bridge. At the falls, which are over heavy beds of red and green shale, holding *Obolella pretiosa* with thick, interstratified beds of grey sandstone, the strata dip S. $< 40°$, the sandstone and grit being largely developed below this point to the mouth of the Chaudière. To the west of this river they continue along the south bank of the St. Lawrence for

Sillery sandstones and shales.

Lévis to Chaudière Junction.

Chaudière River, lower part.

about three miles, when the exposures of grit and sandstone cease, the shore above showing beds of red, green, black and grey shales. Along this part of the river the diverse dips visible show this portion of the Sillery formation to be thrown into a series of folds, equalling those which are found in the the rocks at Lévis and below that place. On the St. Lawrence section above the Chaudière, after passing the outcrops of sandstone, the red and green shale series extends to a point two miles above the wharf at St. Nicholas, where the fault from the north side of the river brings them into contact with fossiliferous strata of Hudson River age, the particulars of which have already been given. To the south of the St. Lawrence, along the line of the Grand Trunk between the Chaudière and the Becancour rivers, but few outcrops of rocks are visible. Where seen they consist of red, green and black shales, with an occasional low ridge of hard Sillery sandstone, similar to what is visible at the railway bridge on the Chaudière, and where the inter-stratified beds of black and green shale contain abundance of *Obolella pretiosa*, with *Protospongia fenestrata*, *Lingula* and two species of *Phyllograptus*. This fauna may be classed as that of the upper Sillery.

West of the Chaudière River.

Fossils from Chaudière at Railway Bridge

On the west or Quebec side of the St. Lawrence a carefully paced section was made along the shore from that city to the mouth of the Jacques Cartier River. The part more particularly referring to this group of rocks is that included between Wolfe's Cove, two miles above the city, where the fault between the rocks of the citadel and those of the Sillery formation reaches the shore, and a point one mile and three-quarters above the mouth of Cape Rouge River, where the fault between these rocks and the Hudson River formation comes to the river from the vicinity of Ste. Foye. In this section, which apparently comprises all the members of the Quebec group visible on the north side of the river, no trace of the Lévis fossiliferous shales and conglomerates is seen. The section is presumably an ascending one from the contact fault above Cape Rouge to the extremity of Point à Pizeau, though several local faults in the upper Sillery portion have complicated the structure somewhat.

Cape Rouge to Wolfe's Cove.

The lowest rocks seen in this section, according to this view, are hard quartzose sandstones, calcareous in the joints, and associated with black, grey and green shales and occasional thin bands of limestone, and holding a band of limestone conglomerate four feet thick, which is made up of small pebbles of hard grey limestoneand white quartz, in a very hard, greyish, siliceous paste, the whole differing greatly in aspect from the conglomerates of Lévis. The quartzites form a ridge or hill, over which the road up the river from Cape Rouge passes, and along which the beds are well exposed. They dip south-easterly $< 50°-80°$. Occasionally pebbles of greyish limestone are scattered

Characters of the rocks near Cape Rouge

Cape Rouge village.

through the quartzite. These rocks extend along the shore toward Cape Rouge for nearly a mile, beds of green, grey and black shale predominating in their upper part, many of which are covered with fucoids, and approaching the mouth of Cape Rouge River a few beds of dark-red shale are seen. Along the road going up the steep hill above the village the black, green and grey shales are well seen in the cuttings, but, though closely examined, no graptolites or other fossils were found. Following the shore northward, these shales clearly underlie the dark-red and green shales of the headland from which this locality takes its name, and they shew, a short distance further east, interstratified beds of Sillery sandstone, in which the Sillery quarries are situated. Thence those alternations of red and green shales and sandstones extend almost to Pointe à Pizeau, the sandstones terminating about half a mile west of the road leading to the Sillery church at this place. The lenticular and often local character of the sandstones already noticed is well seen in this section. From Point à Pizeau to Wolfe's Cove no sandstones show, the rocks being red, green and black shales. From these, in the cliff in front of Sillery church, *Obolella pretiosa* was obtained, the rocks being precisely like those at the Grand Trunk Railroad bridge over the Chaudière. The strata along this part of the section are thrown into several folds, and faults, generally local and probably of small extent, are visible at several points. The areas of sandstone in rear of Sillery are in no case of any great thickness, that in which the quarry is located being probably as thick as any; its surface breadth on the road to the west is 320 paces, with an estimated vertical thickness of about 250 feet, in which, however, several partings of shale occur. The contact of these red and green shales of the Sillery series with the black bituminous shales and dark-brown bituminous limestones of the citadel series is well seen fifty paces north of the forks of the road leading up the hill from the head of Wolfe's Cove, a deep gully marking its probable course, and the fault extends thence through the grounds of Spencer Wood in a direct line to the forks of the road east of Ste. Foye, whence it changes its course and passes to the north of that village, 100 yards from the main road, changing again a short distance west, and extending thence to the St. Lawrence above Cape Rouge, as already indicated. By the fault north of Ste. Foye the grey shales and sandstones of the Hudson River series are brought into contact with the red and green shales of the Sillery.

Point à Pizeau.

Fault at Wolfe's Cove.

Rocks of Quebec City.

In the report of 1863 the shales, limestones and conglomerates of the Citadel and city of Quebec were supposed to belong to the upper part of the Lévis formation, and to underlie very closely the red shales of the Sillery, though their true position was even then regarded as very doubtful.

The subsequent study of these rocks by Dr. Selwyn brought some new facts to light, from which, both on stratigraphical grounds and from the evidence of fossils collected at several points in the city, it was decided that the position of these rocks was much newer and altogether above the Lévis and Sillery strata. Additional large collections of fossils from various points in thecity were made during the past season by Messrs. Ami and Giroux, the result of the examination of which, and some points in regard to the structure, will be given further on. Recent collections of fossils at Quebec.

From Wolfe's Cove the red and green shales of the Sillery cross the St. Lawrence and appear on the east side at Point Lévis, where their distribution has already been given, and none of the graptolitic shales or conglomerates of the Lévis series have been recognized on the north side of the river, these being confined in this area to the town of Lévis itself, where they rest on the red and green shales, as described, whence they extend to St. Joseph and along the shore for about two miles below, as indicated by the fossils enumerated on page 58K. Thence crossing the south channel of the St. Lawrence, they constitute a limited area in the extreme south-west end of the Island of Orleans, the southern margin of which is seen to be terminated by a well-defined fault between the limestone conglomerates, with their associated fossiliferous shales, and the red and green slates, near the foot of the stairs leading up from the head of the small cove east of the hotel. On the north side of the island these Lévis rocks are terminated by the great fault which brings up the black bituminous shales and limestones, which have been formerly described as of Utica or Hudson River age, and which are the undoubted extension of the rocks of the city of Quebec. From these Lévis rocks at the end of the island the following fossils have been obtained:— Absence of true Lévis rocks on north side of St. Lawrence River. Island of Orleans south-west end.

1. *Clonograptus rigidus*, Hall.
2. ? *Dichograptus octobrachiatus*, Hall.
3. *Dichograptus ? Richardsoni*, Hall.
4. *Ptilograptus plumosus*, Hall.
5. ? *Tetragraptus serra*, Brongniart.
6. *Dawsonia*, sp. indt.
7. " *acuminata*, Nicholson.
8. *Acrotreta*, sp. nov.
9. (?) *Turrilepas*, sp., fragments, with the surface marked by concentrically arranged lines of growth.

On the south side of the ledges on which this hotel is built Mr. T. C. Weston obtained *Loganograptus*.

Leaving for the present the development of these rocks as seen along the shores of the St. Lawrence and the several islands which lie in the

channel below Quebec, we will examine the structure of the group as displayed in the sections along the Etchemin and Chaudière rivers.

Etchemin River section.

On the first of these streams the rocks of the Sillery, more particularly the sandstones and associated shales, have already been referred to as extending upward to within one mile of the railway bridge on the Intercolonial Railway. Above the last exposure of the Sillery sandstone formation the red, green and black shales extend for fifty chains, beyond which, to the bridge, grey, green and black shales, probably representing a slightly lower series, occur. The great falls of the Etchemin occur ten chains below the bridge, and the green and black shales here have yielded to Mr. Weston *Obolella pretiosa*, a form similar to that from the Sillery of Point à Pizeau. Above the bridge the green, black and grey shales extend to a small brook about two and a fourth miles below St. Henry village, the dips all along being south 20°–30°. At this brook the red and green shales again come in on the south side of the anticlinal and extend up to the village, in which space several foldings are seen, but the general character of the red, green and black shales is maintained throughout. Above St. Henry the river flows for several miles through intervales, and exposures are rare both on the stream and on the road between St. Henry and St. Anselme. Just above the village the stream makes a great bend of nearly two miles to the south-west, and then resumes its regular course. Three-fourths of a mile above the upper part of the bend, black and green and grey shales, with hard bands, occur, with a bed of limestone conglomerate, in which Mr. Weston, in 1877, obtained from the pebbles.

Fossils from between St Henry and St. Anselme.

1. *Leptæna sericea*, Sowerby.
2. *Orthis platys*, Billings.
3. *Camerella varians*, Billings.

The associated shales form a peculiar band, which is repeated three times on this river in the next three miles, the intervening space being occupied by red and green shales of the Sillery formation. From the black shales near a grist mill close by the upper exposure, which is a half-mile above the great gorge of the upper fall, the following graptolitic forms were obtained:—

1. *Dicranograptus*, cf. *D. clingani*, Carr.
2. *Climacograptus bicornis?* Hall.
3. *Diplograptus cf. D. mucronatus*, Hall.
4. " sp. indt.; Polypary with closely arranged thecæ,
5. *Dicellograptus sextans*, Hall.
6. " *Moffatensis*, Carruthers, var. *divaricatus*, Hall.
7. " sp. indt.; same form as found in similar rocks from Crane Island.

At this point sharp faultings are seen on both sides of the exposure of black shales, and thence upward the stream shows a succession of red and green shales for several miles above St. Anselme. Toward Ste. Claire beds of grey, green and black shales occur, with bands of hard quartzite of considerable extent, which latter will be described later. Faults.

The occurrence of these black fossiliferous strata on this river is peculiar. At no other point south of the St. Lawrence have they been observed, but on the north side of Crane Island, about one mile above the church, and again on the south side, one mile east of the wharf, precisely similar shales are found containing similar forms. From the north side of the island a small collection yielded: Similar rocks and fossils on Crane Island.

1. *Dicranograptus cf. D. Nicholsoni*, Hopkinson.
2. *Dicellograptus sextans*, Hall.
3. *Dicellograptus Moffatensis*, Carruthers, var. *divaricatus*, Hall.
4. *Dicellograptus*, sp. indt.

A peculiar feature accompanying these black shales is the presence of heavy beds of blackish, very hard, cherty shale, precisely similar to that seen at Griffin Cove, Gagnon's beach and the Marsouin. The presence of *D. sextans* at all these places shows the horizon of the Etchemin shales to be not far removed from the rocks of the localities mentioned, and their position at this place is doubtless that of a repeated synclinal upon the red and green Sillery shales, complicated somewhat by faulting. Cherty beds.

From the red and green shales underlying the black shales just described, Mr. Weston, in 1877, collected *Obolella pretiosa*, fragments of a *Tetragraptus* allied to *T. Headi*, Hall, and the funicle of a *Clonograptus* allied to *C. rigidus* or *C. flexilis*.

The sections on the Chaudière River above the Grand Trunk Railway bridge present, for the most part, rocks of the upper Sillery horizon. Near St. Lambert green sandstones, interstratified with the usual red and green shales, occur, in which Mr. Weston has found an *Obolella* like the form at the bridge below. Above St. Lambert black and green shales, like those on the upper part of the Island of Orleans, near Patrick's Hole, contain graptolites, with fragments of *Obolella* or *Lingula*. Between this and St. Bernard beds of limestone conglomerate, with green and black shales, the pebbles of which contain fragments of Orthis-like shells and Crinoid stems, are found, the associated shales containing *Phyllograptus Anna* and *P. angustifolius*. These indicate a probable synclinal of Lévis rocks at this place, while the underlying Sillery formation is affected by a series of foldings such as are seen to the east on the Etchemin. Sillery shales and fossils. Chaudière River section.

The relative positions of the Sillery and Lévis are well observed in the sections between Lyster and Somerset, on the west, and the Craig road, which passes through Leeds. On the line of the Grand Trunk, between Lyster and Stanfold, the red and green shales and hard sandstones of the Sillery are well exposed at intervals. To the westward of Lyster they show down the Becancour River to the fault, between this formation and the Hudson River rocks, about ten miles from the mouth of the stream. Along the railway these rocks form the western side of a synclinal basin, the eastern edge of which appears at Inverness and St. Sophie. On the road east of Lyster to Ste. Agathe the characteristic red and green-striped shales are seen at intervals to the road leading north between ranges xii and xiii Nelson. Blocks of trap are scattered along this road, outcrops of which occur in places on range xi. The dip of these red slates is south-easterly. One mile south of Ste. Agathe Corner ledges of bluish-grey dolomitic slates and limestone conglomerates dip S. 10° E. < 50°, the pebbles containing traces of fossils, which, however, were not determined, but the rocks look like those of Lévis, and these undoubtedly overlie the red slates of the Sillery. On the road leading south-east from Ste. Agathe to the Craig road these bluish-grey slates, which strongly resemble those of Brompton Falls, below Sherbrooke (see Report 1886), extend for quite three miles, in which probably several low undulations occur, to a well-defined synclinal, the dips being E. and N. 60° W. These slates are like those associated with the limestones of the Arthabaska area, and a short distance east of the synclinal they rest upon limestone conglomerates and grits, with hard bluish-grey slates like those near Ste. Agathe. Further to the north-east these rocks extend towards St. Patrick, and reach the road to Ste. Marie about four miles north-east of St. Sylvester. In some of their undulations these doubtless connect with the fossiliferous strata and limestone conglomerates of St. Bernard, already described. In the vicinity of St. Patrick they rest to the east upon the red and green slates and sandstones of the Sillery.

Lyster and Stanfold. *Ste. Agathe.* *St. Sylvester.* *St. Patrick.*

In St. David a mixture of limestone conglomerates and dolomitic shales of various colors, red, green, grey, etc., occurs, in which very diversified dips are seen, indicating abrupt folds or faults. These probably indicate the synclinal at this place, and they also rest upon the red slates of the Sillery to the west. On the road from Leeds village to Inverness the eastern limit of the synclinal is bounded by red and green Sillery shales and hard sandstones, one mile and a-half east of Glenloyd Mill, where these rocks dip W. < 30°. In the fields a short distance west of this, ledges of limestone conglomerates, presumably the extension of those seen on the road from Ste. Agathe to Craig road, occur. At the mills on the River Becancour the rocks are greyish and

St. David. *Leeds to Inverness.*

bluish-grey-striped massive slates, like those of the Brompton Falls on the St. Francis River, which thence extend south-westerly to Inverness Corner, where beds of limestone conglomerate also occur, with a north-west dip, and resting on hard green and black slates, which are now regarded as constituting a portion of the Cambrian system, the red and green shales being apparently overlapped by the black slates and conglomerate series. Glenford mill.

In the vicinity of Somerset, and between that place and Ste. Sophie, a tract of tolerably flat country extends, with a breadth of several miles. In this area beds of the graphitic limestone and black shales occur, similar to those described as occupying the basins of Arthabaska and Danville. These can be traced to the north-east in rear of Ste. Julie, but there they apparently terminate. They overlie a series of blackish-grey slates, which are like those described as occurring in the Wotton area of the last report, and which in turn rest upon the red shales and sandstones along the east side of the Grand Trunk Railway east of Stanfold. Somerset and Ste. Sophie.

To the east of Somerset, in the direction of Ste. Sophie, these dark limestones rest upon a series of highly altered schists and schistose quartziferous shales, which constitute a high ridge extending towards St. Norbert, and thence form the high belt of hills toward Halifax. In this direction also the red slate series is wanting, and the limestones are in apparent contact with what we have called the Pre-Cambrian series.

From the evidence obtained from so many widely scattered localities, the position of the red slates and sandstones of the Sillery beneath the fossiliferous beds of the Lévis, both upon the mainland and on the upper end of the Island of Orleans, can be assumed with considerable certainty, both on stratigraphical and on palæontological grounds, for, while numerous faults are found, some of which are of great extent, and great overturning of the strata, the overlying position of the Lévis is so often seen in places where their relative positions can scarcely be reversed, that the conclusions above stated are, it is believed, no longer a matter of doubt. Lower position of the Sillery.

Before we take up the consideration of the south side of the St. Lawrence below Quebec and the several islands in the channel, a brief statement of the stratigraphy as now held may be given for the better comprehension of the structure of the St. Lawrence section. Ascending sequence of strata of the fossiliferous Quebec group from Cape Rouge northward.

Beginning, then, with what we regard as the lowest members of the group, viz., the beds near the central fault above Cape Rouge, we have in ascending order:

1. Black, green and grey shales, with hard and heavy bands of greyish, sometimes yellowish-white quartzose sandstone, which are thickest

in the lower portion, and with occasional thin bands of limestone conglomerate, the pebbles being generally small and the paste highly quartzose. The quartzites have occasional scattered pebbles of greyish limestone.

Lower Sillery

2. Greenish, greyish and blackish, with occasionally dark-reddish or purplish-tinted shales, with bands of hard greyish sandstone, generally fine-grained, and in thickness from one inch to a foot, the massive quartzites being absent and many of the greenish layers being covered with fucoidal markings, well seen on the shore above Cape Rouge and in the cutting along the road above that village.

3. Bright-red shales, often with thin greenish or greyish bands, which in places are calcareous. The rocks on a smoothed surface, have a striped red and green aspect; in the upper part occasional beds of a foot or more of hard green-grey sandstone occur.

4. Red, greenish-grey and black shales, with interstratified masses, often lenticular, of greenish and greyish Sillery sandstone, ranging in thickness from two feet upward, in which the Sillery quarries are located. This is the typical Sillery sandstone, which ranges from a fine-grained homogeneous rock to a fine quartz conglomerate, much of the rock being characterized by the presence of small flaky pieces of shale and scattered small pebbles or large grains of clear quartz, the bands of sandstone being separated by partings of various colored shale. The local and lenticular character of the sandstone is well seen in the Sillery section, some of the heaviest beds inland thinning out before reaching the shore in either direction. In the upper part, at Sillery church, *Obolella pretiosa* occurs, from which point an anticlinal crosses the river to Point Lévis, and appears in the cliffs at the Victoria Hotel, where the same *Obolella* is found.

Upper Sillery.

Lévis.

5. The Lévis shales and conglomerates of Lévis city and the shore and cliff below South Quebec and St. Joseph and the west end of Orleans Island, the synclinal disposition of which has already been described.

Upper Chazy or Lower Trenton.

6. The black and greyish-striped or banded shales, overlaid or associated with the black and graphitic shales and limestones of the Arthabaska and Somerset synclinal, which latter do not appear in the Point Lévis and Quebec sections.

Trenton-Utica.

7. The black or brownish bituminous shales and limestones of the city of Quebec and north-west side of the Island of Orleans of Trenton-Utica age.

The south shore of the St. Lawrence below Lévis displays, for several miles, strata abounding at certain points with graptolites, the principal forms of which have already been enumerated. Thirty chains below the lowest fossil locality, or three miles below the ferry

wharf at St. Joseph, a well-defined fault is seen, the strata in the intermediate space being thrown into several sharp folds. This fault brings up a series of limestone conglomerates and shales, which in aspect resemble the rocks of divisions 1 and 2 of the Cape Rouge section. The conglomerates here occur in thin bands, of which the first has a thickness of fifteen feet in the cliff, thinning into three feet on the beach. Band 2, separated from this by thirty-three feet of greenish and greyish shale, is eleven feet thick, and is made up of large and small pebbles of siliceous dolomite and grey limestone, in a hard siliceous paste. Band 3 has nearly all its pebbles of dark-grey limestone, with calcite and thin pieces of shale, with a thickness of ten feet, and is flanked on the south-east side by grey sandy and quartzose flags and green-grey shales. The series dips S. 65° E. < 55°. The pebbles of the conglomerate yielded fragments of trilobites, which have been examined by Mr. Ami and found to be portions of *Olenellus Thompsoni* with *Olenoides* or *Microdiscus*. The hard quartzose sandstone on the east flank contains also scattered pebbles of greyish limestone.

Shore above Beaumont.

Fossils.

The fault at this place apparently marks the eastern limit of the fossiliferous or graptolitic shales of the Lévis formation, and no beds of Lévis aspect appear east of this point, as far as our observations extended during the past season. Between this and Beaumont green and grey slates, with thin, hard bands of quartzite, and occasionally thin, grey limestones and fine limestone conglomerates occur, which represent the rocks of division 2. From certain hard, sandy beds, one mile east of the conglomerates, numerous graptolitic forms were obtained, most of which were, however, fragmentary and difficult to determine. They are, however, similar to others found near St. Michel with *Obolella pretiosa*, and may, therefore, be assigned generally to the fauna of the Sillery.

Eastern limit of the Lévis on the shore.

In this space the strata are most intricately folded; the green hard slates and sandstones constituting the lower part and showing at times in the anticlinals, while in the synclinals the red and green striped shales come in. A mile and a-half west of Beaumont Brook, ten anticlinals can be seen in the space of fifteen chains, the rock being the hard greenish-grey shales and hard quartzite beds of division 2. The apparent plasticity of the rocks at the time of their folding is here remarkably displayed, since the beds curve in sharp bends without the smallest indication of crushing or cracking, the hard sandstones apparently being precisely the same on the concave side of the arches as in the convex. Many of the green shales associated with the red along this part of the coast are thickly marked with beautiful impressions of fucoids. The beds of the Sillery sandstone do not appear, though heavy beds of hard grey quartzite show at intervals,

Beaumont.

but these are apparently the equivalents of the lower part of division 1 of the Cape Rouge section. Frequent faults occur, and below Beau mont Brook these are repeated every few chains, their position being in many cases marked by a jog in the coast line, which follows the line of the fault, and a similar series of green, grey and red shales is repeated several times.

Beaumont to St. Michel.

But little variety occurs in the character of the rocks between Beau mont and St. Michel de Bellechasse. Repetitions of green, grey and black shales, with hard quartzites and occasional thin bands of lime stone conglomerate form the anticlinals, and red and green shales with thin hard bands of calcareous sandstone, and reddish limestone, at times dolomitic, shew in the upper part. Those rocks strike from north to north-east across the south channel of the St. Lawrence, and reach the south side of the Island of Orleans, between St. Laurent and its east end called Traverse Point, the strata of that section being identical with those of the shore just described. One mile east of the wharf at St Michel, green, grey and black shales and thin hard sandstones, overlaid by reddish shales, contain fossils, among which were recognized:

Fossils from St. Michel.

1. ? *Dichograptus ramulus*, Hall.
2. *Dendrograptus*, sp.
3. *Dawsonia*, sp.
4. *Obolella desiderata* ? Billings, or a closely allied species.
5. *Obolella pretiosa*, Billings.
6. *Acrotreta*, sp.

Half a mile further east, in a band of black shale, *Dictyonema*, *cf.*, *D delicatulum*, Dn. (preoccupied), and a species of *Bryograptus*, are found

St. Michel to Vallier Point.

From this to the extremity of the point, two miles below the whar at St. Michel, the usual series of black, green and red shales occupy the shore. At the point a well defined anticlinal brings up the black green and grey shales of division 2. These extend across the strike to the mouth of the Boyer River, near which another crushed anti clinal in similar rocks is seen. Thence to Vallier Point, which is the west extremity of Bellechasse Bay, the rocks of division 2 are continu ously exposed, being overlaid to the south along the road, beyond St Vallier Church, by the red shales and sandstones of the Sillery. Twenty chains south of Vallier Point these older rocks are overlaid by the red shales on the shore of the west side of the Bay, whence they extend to Berthier Village.

Berthier to St. Thomas.

East of Berthier to St. Thomas the shore is entirely occupied by the red and green shales, and grey or occasionally brown sandstones of the true Sillery of division 4. They strike along the shore, which keeps nearly along the crest of an anticlinal fo

several miles. In the Village of St. Thomas these shales have yielded *Obolella pretiosa* and sponge spicules. Thence to L'Islet the same rocks are continuously exposed, the headland of Cape St. Ignace being composed of the Sillery grits. Near L'Islet, in the green shales associated with the red, *Obolella pretiosa* and an allied form probably *O. desiderata*, were found at several points, the rocks in the intermediate space being thrown into a series of anticlinals with south or north dips at angles of 60° to 85°. St. Thomas to L'Islet.

East of L'Islet the red and green shales present heavy ledges which form prominent ridges along the shore for some distance, and extend to the Trois Saumons River. At the L'Islet wharf the associated sandstones contain an interstratified bed of fine limestone conglomerate four to ten feet thick, with small pebbles of limestone and quartz, which shades off into grit. Along this part of the coast the strike follows the shore line, the dip being S. 30° E. $<$ 60°–80°. Between Trois Saumons and the brook one mile to the east, the green and black shales with thin hard bands occupy the shore, an anticlinal occurring midway, and thence east to near the wharf at St. Jean Port Joli the ordinary red and green shales of division 3 are seen. Slightly lower beds occur at the wharf at St. Jean, with thin beds of hard grey limestone; but 150 paces east red and green shales again come in and extend to within five miles of the church of St. Roch des Aulnets. At this place a series of anticlinals show on the several points bringing up the lower beds of division 2, with bands of greyish limestone holding remains of small trilobites, among which an *Agnostus* was recognized. These are associated with black and green shales, and they are repeated at intervals for one mile and a-half along the shore, when a fault and sharp anticlinal again bring into view the red and green shales which extend thence to St. Roch. L'Islet to St. Roch. Fossils.

In these red and green shales *Obolella pretiosa* also occurs, and near St. Roch the beds of hard Sillery sandstones have associated beds of limestone conglomerate, which now begin to constitute an important feature in the Sillery rocks of this area. In no part of the shore have we found any rocks which, from their lithological character or their contained fossils, should be assigned to a lower horizon than the lower Sillery. From this to River du Loup the shore presents the same general aspect, except that the quartzites which have a considerable development to the south of St. Michel and St. Thomas come to the shore above St. Roch, owing to a sudden change in the strike northward towards the St. Lawrence at this place. This northward change of strike extends from a point four miles west of St. Roch to the St. Roch Post Office and Brook, which is two miles east of the church. Beyond this the strike rapidly assumes a more St. Roch to River du Loup.

easterly direction, which continues along the shore. By this deflection the heavy beds of quartzite, with the associated red and green shales which form the prominent ridges to the south from St. Gervais to L'Islet are brought to the coast, and thence extend to and beyond River du Loup. In all this stretch of coast from St. Michel to River du Loup no fossils other than *Obolella* and sponge spicules have been found, with the exception of a small collection of bivalve shells and fragments of trilobites near Notre Dame du Portage, and some indistinct graptolites associated with *Obolella*, at the crossing of the Ruisseau de L'Eglise, on the Intercolonial, and three miles east of St. Paschal station, among which were *Climacograptus*, sp., *Diplograptus*, sp., *Nemagraptus*, sp. indt., *Didymograptus*, (?) sp.

Notre Dame du Portage.

Fossils.

In the collection from Notre Dame du Portage the following genera were recognized:—

1. Obscure graptolite, with a long stipe.
2. *Lingula*, sp. nov. (?), (a small narrow shell, with brown test and lamellar lines of growth.)
3. *Obolella*, like a young specimen of *O. pretiosa*.
4. *Orthis*, sp.
5. Strophomenoid shell.
6. Fragments of a pteropod-like organism.
7. *Beyrichia*, sp. (With prominent crescentic sulcus and eccentric lobe.)

The relations of the areas of quartzose sandstones, and red and green shales of this interior belt to the typical Sillery of the coast section, may now be considered; and this is an important point, since in the Report, 1869, as already pointed out, these rocks were in part regarded as of Potsdam age, on the evidence of *Salterella* in the pebbles of the associated conglomerates and supposed markings of *Scolithus*. South of Lévis, the ridges of Sillery sandstones, which are often of considerable extent, occur as lenticular areas, and extend on the St. Henry road for about three miles. To the south of this, along the Etchemin, the sandstones do not apppear till we reach the vicinity of Ste. Claire; the intervening space being occupied by the series of red, green and black shales, already described. Eastward to St. Charles junction, the rocks described on the coast section about Beaumont, shales of various colors are found, but a couple of miles east of St. Charles, ridges of the Sillery sandstone rise from the flat country to the south of the railway. Between St. Charles and St. Gervais red shales occur, which, along the course of the Boyer River, extend to St. Henry. A low ridge of the Sillery is seen near the road to St. Gervais, about two miles

St. Charles to St. Gervais.

south of St. Charles. At St. Gervais a very considerable development of this highly quartzose sandstone begins, the composition of which, except for its rather more siliceous aspect, is precisely like the rock of the Sillery quarries, small pebbles and grains of quartz, and pieces of greyish or black shales, often of considerable size, being found. As with the typical Sillery of the shore, the hard quartzites are interstratified with red, green and black shales. South of St. Gervais, towards St. Anselme, these rocks terminate about three-eighths of a mile from the corner, beyond which the red and green shales continue to St. Anselme. About one mile north of the road between St. Anselme and St. Henry, and a short distance west of St. Anselme, a heavy boss of trap cuts through the shales, with which are associated at this place beds of sandstone and grit of Sillery aspect. Along the road leading south-west from St. Gervais, Mr. Weston obtained the usual Sillery fossil, *Obolella pretiosa*, from the green and red shales. Between St. Gervais and St. Raphael, the quartzite forms conspicuous white weathering ridges, their interstratification with the red, black and green shales being well seen at the brook and mill, one mile and a half north-east of the former place. Here, Mr. Weston also obtained *Obolella pretiosa*, a Linguloid shell, crinoidal fragments and a *Buthotrephis*. The same *Obolella* was obtained from interstratified shales in quartzite at River du Sud, beyond St. Raphael, also near St. Francois church, at St. Thomas and at Berthier, the specimens being in all cases precisely similar to those found at the railway bridge on the Chaudiere.

St. Gervais to St. Anselme.

St. Gervais to St. Raphael.

Between St. Thomas and L'Islet the ridges of quartzite and shales form a range of hills, just to the south of the back concession road, about two miles and a half from the Intercolonial railway. About St. Aubert these quartzose rocks vary much in character, at times being hard and siliceous, at others resembling the typical Sillery rock. Considerable areas of limestone conglomerate are associated with them near this point, as well as in the ridges three miles south of St. Thomas. They first show along the shore road in conspicuous beds on the road between St. Jean Port Joli and St. Roch, about three miles below the former place, where they are clearly an interstratified portion of the red and green shale and sandstone series of the Sillery formation. The conglomerates are composed of pebbles of quartz, greyish limestone and sandstone, cemented by a gritty and highly quartzose or sandy paste. On the Elgin road, which goes south about four miles below St. Jean, hard quartzose sandstone, with limestone conglomerate and red and green shales, occur at intervals to the railway. South of this, exposures of sandstones are also seen, but at the corner of the back road leading across to St. Aubert, great ledges and ridges of this quartzose sandstone come in. This rock, while weathering white, is, on fresh

St. Aubert.

Elgin Road.

fracture, a brownish grey, in which respect it resembles the bands of Sillery sandstone on the Island of Orleans, below St. Jean. The associated conglomerates are made up of large and small pebbles of greyish and sometimes brownish sandy limestone, sandstone and quartz and the mass of the sandstone contains bits of shale and pebbles of quartz, like the typical rock of Sillery; the associated black and green shales west of St. Aubert contain *Obolella pretiosa* also.

Change in strike.

Near St. Aubert these rocks change their strike and run towards the coast, reaching it above St. Rochs, as already described. Further east a repetition of these show in similar conspicuous ridges and rounded hills, which rise abruptly from the flat plain along the line of the Intercolonial between St. Roch and Ste. Anne de la Pocatière. In many places the ridges of quartzose sandstone west of and in the vicinity of Ste. Anne have interstratified beds of limestone conglomerate, like that near St. Aubert. These ridges of conglomerate and quartzite west of Ste. Anne have an anticlinal structure, the opposing dips to the north and south being well seen on the road half a mile west of the church. The anticlinal in the underlying red and green Sillery shales is also seen just on the rise of the hill south of the church, and again one mile east of the village. That these beds of shale, quartzite and conglomerate are of the horizon of the Sillery further west is seen in the presence of *O. pretiosa*, as well as in the general character of the strata. In the conglomerates, many of the pebbles are derived from some lower band of limestone conglomerate. The same peculiarity was observed in the rocks of the Brandy Pots, lying in the St. Lawrence off River du Loup, where precisely similar beds occur as at Ste. Anne. The same character of sediments occupy the country about Kamouraska and the back country, showing along the several roads running southward towards the boundary. These have already been described fully in the report of Mr. Richardson, 1869. On the road from River du Loup to Lake Temiscouata they occupy the section between the St. Lawrence and nearly to the crest of the ridge at St. Honoré, midway to the lake, alternations of red, green and black shales, with great areas of whitish weathering quartzose sandstone, being visible at intervals; but at St. Honoré, the underlying black, wrinkled slates of the Cambrian anticlinal come into view, and extend southward to the vicinity of St. Louis de Ha Ha. This country has been worked out by Messrs. Bailey and McInnes.

Ste. Anne de la Pocatière.

River du Loup to Lake Temiscouata.

Orleans Island to Crane Island.

The islands which lie in the channel of the river below Quebec form a chain nearly forty miles in length, extending from Orleans Island to the Isle of Cranes, which is opposite to St. Thomas and L'Islet. Of these Orleans Island is the largest, having a length of twenty miles from the South-West Point to Point Traverse, and a breadth in its widest

part of about five miles. Along its shores, three rock formations are recognized, viz., that on the north side, hitherto regarded as of Utica or Hudson River age; that on the south-west end known as the Lévis, and that of the south, and, in fact, comprising nearly the whole of the island, which we regard as the Sillery, and probably, in great part, its lower portion. The rocks of the Levis formation of the south-west end, with their contained fossils, have already been described on p. 59 K. The rocks of the south shore to Traverse Point are identical in character with those of the shore from above Beaumont to St. Michel, being, in fact, the extension of those across the river channel to the island. Like those of the mainland, they also contain *Obolella pretiosa*, with fragments of graptolites at several points, but no traces of the Lévis rocks proper are seen below the fault which cuts off this formation east of the Island Hotel. The Sillery sandstones are but slightly developed. On the line of section between St. Jean and St. Famille, and at the eastern half of the island, the general structure is seen to be that of a double anticlinal, affected by various minor folds, along which, at two points, hard Sillery sandstones come to view. On the north-east end of the island, heavy beds of coarse, green, sandy shales, passing at times into a shaly sandstone, occur along the road between St. Famille and St. François. These are associated with red and green shales along the shore, in which respect they are like the Sillery, and at the east end of the island include a band of limestone conglomerate twenty feet thick, which in aspect is like that described from St. Aubert and St. Anne de la Pocatière. It is probable, therefore, that the great bulk of the sediments on this island is the true equivalent of the Sillery formation. The rocks of the north side which are separated from those just described by a well-defined fault of considerable extent, are divisible into two portions. Of these the lower series, stratigraphically, is the black bituminous shale and brown limestone of the extreme north-west end, called False or West Point. The rocks extend along the road towards St. Pierre for seventy chains, where their contact with the green and grey shales of the Levis formation takes place. At a small brook about half a mile farther east, the limit of the black bituminous shales is seen, a fault separating them from the grey and green-grey shales. Below this point, greyish and greenish shales and sandstones of Hudson River age occupy the shore, and show along the road down the north side of the island for several miles above Ste. Famille. They are also seen on the road traversing the island to St. Jean for nearly three-fourths of a mile south of Ste. Famille Corner, the exposures not being continuous, but below Ste. Famille they are readily seen for one mile and three-fourths to the sharp bend in the road

Orleans Island, three formations.

North side of Island.

Hudson River rocks.

to the southward and a small brook, where they are brought into contact with the red and green shales of the Sillery by a fault. This fault is well seen on the shore two miles east of Ste. Famille, the rocks of Hudson River age being greyish sandstones and shales, with beds of greyish limestone, which are much crushed along the line of contact. Graptolites of Hudson River type occur in the shales at this place.

Concerning the age of the greyish beds of this section there can be but little doubt. They are identical in character with those from the opposite or north side of the St. Lawrence, as well as those of Ste. Croix, above Quebec, which contain typical Hudson River forms. But the Utica age of the blackish shales and limestones is still somewhat uncertain. Large collections of fossils were made from these strata during the past season, which show them to be of the same horizon as the rocks of the Citadel Hill, Quebec, as well as those of the north side of the Gaspé Peninsula, of the Marsouin River, Griffin Cove, and Gagnon's Beach.

Probable age of the black shales and bituminous limestones of the north side.

The black shales and limestones below the village of St. Pierre, which should underlie the Hudson River strata, are not visible along the north side of the Island, owing probably to the great stretch of mud flats in this direction; but they should occupy a portion of the North Channel, and be brought into place by a fold or anticlinal in this direction, which repeats the Hudson River beds of the north side.

From the conclusions of Prof. Lapworth it seems probable that the horizon of the black shales is that of the upper part of the Trenton or transition to the lower Utica, but closer study of the fossils from Quebec will be necessary to definitely determine their exact position.

Rocks of the south side

Between the fault which cuts off the Lévis on the south side, east of the Hotel, and the village of St. Laurent, five miles and a half distant, sixteen well defined anticlinals are recognized in the rocks along the shore. These consist for the most part of red, green, grey and black shales, with hard bands of grey sandstone which are sometimes of considerable thickness, like the strata of Point à Pizeau and Sillery. In some of the anticlinals, the hard grey quartzose sandstone and green shales of the lower part of the Cape Rouge section are brought to view, and occasional beds of hard siliceous limestone conglomerate, like that above Beaumont, come to the shore in beautiful folds, overlaid in the synclinals by the red and green shales of the upper Sillery series.

St. Laurent to St. Jean

Below St. Laurent, toward St. Jean, the shore for some miles is occupied by the red shales. Midway, black and green shales hold *Obolella* and imperfect graptolites, the rock resembling that of the Chaudière Bridge. Below St. Jean, the red and green rocks continue to the mouth of the Delphine River, beyond which the series of green,

black and grey shales and quartzose sandstone, which constitute divisions 1 and 2 of the Cape Rouge section, come in and extend in a series of folds to the eastern extremity of the island, around which they are well exposed to the cove at the north-east end.

St. Jean to Ste. Famille.

A section on the road between St. Jean and Ste. Famille passes over two well defined ridges separated nearly midway by a flat half a mile in width, through which a brook flows eastward. The southern portion of each ridge is composed of red and green striped shales, underlaid by green-grey shales and hard sandy beds, indicating the two anticlinals noted above.

Madame Island.

Madame Island and Isle Reaux lie to the south-east of the east end of Orleans Island, and distant from it one and a half to two miles. The former, or more westerly, has a length of 130 chains and a maximum breadth of thirty chains. The latter has a length of 225 chains and a breadth of about twenty-five chains. At low tide, extensive reefs of shale and sandstone extend in all directions, and nearly connect the two islands. They are both generally flat, but each has a low ridge extending along the centre of the island. Madame Island is composed entirely of grey, green and black shales, probably of division 1, with several prominent reefs of hard quartzose sandstone off the east end, similar to those found at Traverse Point on the east end of Orleans Island. These reefs curve across the flats at the east end, and then bend sharply to the eastward, where they skirt the flats to the southward of Reaux Island, being visible at low tide.

Reaux Island.

The rocks of Reaux Island are slightly higher in the series, being black, green, grey and red shales, like those near St. Michel on the main land, and contain *Obolella pretiosa*, as at that place. In neither of these Islands do beds of limestone conglomerate appear. Grosse Isle, which is the seat of the Quarantine Station, lies one mile and a-half south-east of the east end of Reaux Island. This island, with Patience, the Brothers, Barrier, Two Head, Canoe, Mill, Race, Margaret and Cliff islands, forms a chain lying about the centre of the River, and showing rocks of general similarity. On all of these islands, some of which are of small size, the strata are greatly folded. In the Report of 1866–69, the most of these rocks were assigned to the Lauzon division of the Quebec group. The rocks of Grosse Isle may be described as fairly representing the rest of the group.

Grosse Ile.

Along the north side and forming the greater part of a ridge which traverses the central and western half of the island, grey and greenish sandy shales, holding scattered pebbles of limestone, occur in places forming a tolerably coarse sandy grit, like that in the north-east end of Orleans Island. This, probably, represents the lowest part of the series, succeeding which, on either side, are beds of greenish-grey sandy shales,

holding many pebbles of limestone and passing gradually into a true shaly limestone conglomerate. These directly underlie the limestone conglomerates proper, which occur in beds from two to ten feet thick, associated with red, green and black shales, hard sandstones and dolomitic limestone. The general aspect of these rocks is similar to the conglomerates of Beaumont and the east end of Orleans rather than to those of Lévis. While several foldings occur, the general structure of the island is that of a double anticinal, the synclinal extending through the centre, and being occupied by the red and green shales of the upper Sillery, without the beds of sandstone. These red strata occupy most of the south side of the island, more particularly east of the Quarantine wharf; the extreme west point, which is a small island at high tide, being composed of green grits like the rock of the northern ridge. The limestone conglomerates are especially developed on the north-east shore, where they extend west for fifty chains from the eastern extremity. From the pebbles, small fragments of trilobites were obtained, but no fossils preserved sufficiently for determination.

Patience Island

Patience Island lies to the north of Grosse Isle, five-eighths of a mile distant. It consists of a central ridge of the same green sandy shales and grit, flanked on either side by the slaty conglomerate, with heavy beds of limestone conglomerate on its eastern end, where the rocks are thrown into a series of sharp folds, the synclinals being occupied by red and green shales. The same rocks are seen in each of the Two Brothers, which lie midway between the eastern ends of Patience Island and Grosse Isle. On Barrier Island, sixty chains north-east of the latter, only the green sandy shales remain, in which, however, the anticlinal structure is visible.

Two Head Island.

On Two Head Island, which presents to the west a bold, almost impassable cliff of the hard, green, shaly sandstone, these rocks are flanked on the south side by the pebbly shales, but on the north by a very complicated set of limestone conglomerates, and red and green shales. The arched structure of the conglomerates is beautifully seen at several points, and especially in a small detached islet off the east end, where the rocks have been cut squarely off, and present a very fine section, showing the green gritty shales at the base, the pebbly green slates and red beds above, and the limestone conglomerates at the crest of the anticlinal.

Crow and Heron islands.

There are two small islets, Crow and Heron, to the north-east of Two Head; the most westerly of these, Heron, shows a synclinal at the western end, from which the limestone conglomerates have been swept away, the green, sandy shales remaining. On Crow Island the north side is occupied by the usual green, sandy beds, while the south shows red and green shales of Sillery aspect. The structure of this islet is

also a synclinal. Further east, Canoe Island lies to the north of Crane Island, and has a length of 125 chains and a maximum breadth of twenty chains. The rocks present a very complicated series of foldings, but are very uniform in character with those just described. Limestone conglomerates are found in small patches at various points all round the island, resting upon the green, sandy shales, and pebbly conglomerates, as on Grosse Isle. From the pebbles of the conglomerates at the east end fragments of *Olenellus Thompsoni* were obtained, in which respect they resemble the beds above Beaumont and at the east end of Orleans Island.

Canoe Island.

To the south-east of Grosse Isle are Cliff and Margaret islands, the former being a prolongation of the latter, but separated by a narrow channel. Cliff Island is composed almost entirely of the green, sandy shales, which form a bold, rugged cliff along the north side, and in which an anticlinal structure is apparent running through the centre. On the south side these are flanked for a short distance by the pebbly shales. The underlying green shales extend across to Margaret Island, and form a ridge at the north-west end for three-fourths of a mile, underlaid on the beach to the north by a series of black, green and grey shales of division 2 of the Cape Rouge section. The south-east side of the island is flanked by the red, green and grey shales of the Sillery. The foldings of the east end of the island are very complex, the succession as seen in the other islands being repeated in cross-section four times in twenty chains. No fossils were obtained by us from these rocks, though Mr Richardson reports finding *Phyllograptus angustifolius* and other species in the rocks of the south side. These must have come from some bands on the flats below high water mark, which overlie the red and green shales as at Lévis. The extreme length of Margaret and Cliff Islands is two miles and three-fourths, with a breadth in the widest part of twenty-five chains. To the south-east of the east end of Margaret Island, and between this point and Crane Island, lie four small islands. Of these the first is ten chains from the shore, and has a length of about eight chains. It consists of green shales, flanked by red, and forms the southern side of a synclinal between this and Margaret Island. The next in order is Middle Island, about the same size, also consisting of green, sandy and red shales. Race Island has an anticlinal structure, the lowest rocks being the green, sandy shales, already described, flanked by the pebbly shales, the red beds being absent. Mill Island, a short distance east of the last, is the same, but has a patch of the red shales and limestone conglomerates on each side, flanking the anticlinal, while Haystack Island, separated by a narrow channel from Mill Island, shows also an anticlinal structure in the green shales.

Cliff and Margaret Islands.

Islands between Margaret and Crane Islands.

The last remaining island of the group, viz., Crane Island, which is connected by a considerable stretch of marsh with Goose Island to the east, differs somewhat from those just described, and which, from their similarity, evidently represent the crests of a series of anticlinals in the lower Sillery rocks. The rocks of Crane Island were regarded by Mr. Richardson as belonging to the Lévis and Lauzon divisions, with a band of Potsdam at the western extremity. They may be briefly described as follows. Along the south shore from the western end to a point three-fourths of a mile east of the wharf, are green, grey and black shales, with thin, hard, sandy bands, like those of division 2 of Cape Rouge, which apparently form an anticlinal extending through the centre of the island, and flanked by the red and green shales of division 3 or lower Sillery. At the extreme western end heavy beds of hard, grey quartzite appear, which resemble the hard bands of division 1. These are flanked along the north side by red, green and grey shales, like those of St. Michel, of which they are without doubt the equivalents. These rocks overlie the green and black shales, the latter occupying the flats and the cliff, the former extending along the course of the island inland, and crossing to the north shore forty chains west of the church, or about one mile and three-fourths from the west end. Sixty-five chains west of the church at this point, where the road comes down to the beach, a band of black shales, with hard, cherty beds, precisely similar to those described on the Etchemin, occur. Evidences of faults between these and the red and green shales are plain, and in character these black beds represent those of the Marsouin. They are fossiliferous, containing graptolites of the following species:

Crane Island.

Fossiliferous black cherty shales.

1. *Dicranograptus*, cf. *D. Nicholsoni*, Hopkinson.
2. *Dicellograptus sextans*, Hall.
3. " *Moffatensis*, Carruthers.
4. " var. *divaricatus*. Hall.
5. " sp. indt.

These are distinct in character from the other rocks of this section from loose pieces of which *Obolella* were obtained. On the south side of the island, sixty chains east of the wharf, a similar band is seen, but this appears to be intermediate between the green, black and grey shales of the lower series and the red and green shales of the Sillery formation, due probably to a fault. Crossing the island from near the church, red and green shales are exposed for about ten chains, then black, green and grey shales of the anticlinal to the south side of the island, upon which the red and green shales are again seen along the shore. Should these black graptolitic shales be the equivalents of the

Utica-Trenton, their positions must be due to a sharp fold or fault between Canoe and Crane Islands, precisely similar to the infolded bands of like character seen on the Gaspé shore below Tartigo River.

There yet remains to be considered the peculiar group of rocks of the City of Quebec, concerning the horizon of which considerable difference of opinion has arisen within the last half-dozen years. In order to find, if possible, some definite clue to their true age, Messrs. Giroux and Ami were instructed to make a carefully located collection of fossils from various points, and from their observations the following conclusions are derived. Quebec City rocks.

The country along the lower part of the St. Charles River, to the north of the great escarpment, is occupied, in part at least, by true Hudson River sediments. These are seen near the foot of the escarpment in contact with black bituminous shales, limestones and calcareous conglomerates, at a point between Côte de la Negresse and Côte Sauvageau, fifty paces west of Tower No. 4, and a little east of a small gully and brook. The fault between the two sets of rock is well marked by a change in the character of the sediments and by a clearly defined difference in strike of the two series. This point marks the most easterly observed contact of the Hudson or Loraine shales proper, with the rocks previously indicated; but to the west this is seen on the slope of the hill, near Ste. Foye, as already noted, where, however, the contact is with the red and green shales of the Sillery formation. On the line of section between Côte d'Abraham and Champlain street, near and a little west of the city wall, large collections of fossils were made at Côte d'Abraham, the rear of St. John Market, in St. Patrick street, and at the Drill Shed, just beyond the Grande Allée, where the following species were obtained, and have been examined by Mr. Ami. Fault north of the city. Fossil localities.

Between the Grande Allée and the Drill Shed.

In black, carbonaceous, flaggy strata, alternating with films of carbonaceous shales, the beds inclined at an angle of 50° south, rock, iron-stained. Drill shed.

1. *Diplograptus foliaceus ?* Murchison.
2. " *angustifolius ?* Hall.
3. " sp. indt.
4. *Climacograptus, cf. C. confertus,* Lapworth. About fifty thecæ in the space of one inch, polypary parallel-sided, and with numerous crowded serratures. Rather common.

5. *Climacograptus perexcavatus*, Lapworth.
6. " *bicornis*, Hall, var.
7. *Dicellograptus ?* sp. indt.
8. *Dawsonia campanulata*, Nicholson.

From between St. John Market and St. Patrick street

1. *Diplograptus foliaceus*, Murchison.
2. " sp., cf. *D. rugosus*, Emmons.
3. " sp., cf. *D. confertus*, Nicholson.
4. " sp. resembling *D. mucronatus*, Hall, but with longer slender spines, which extend outward at an angle of 50° to the axis of the polypary from the angle of aperture of the thecæ.

St. John Market.

5. *Climacograptus bicornis*, Hall.
6. " " var. *caudatus*, Lapworth.
7. " *perexcavatus*, Lapworth.
8. " *scalaris*, Hisinger. var. *normalis*, Lapworth.
9. *Dicellograptus sextans*, Hall.
10. *Corynoides calycularis ?* Nicholson.
11, 12, 13. *Lingula*, 3 sp. All apparently undescribed, and characteristic of these rocks.
14. *Obolella* sp. A small and nearly circular species of this genus appears to be represented.
15. *Acrothele ?* sp. A shell resembling a closely related but smaller species from the Beccaguimic River, N. B.
16. *Orthis*. Fragments of one or more species of this genus occur in the limestone conglomerate band near the St. John Market.
17. *Leptæna*, n. sp. A diminutive species closely resembling that found in the black limestones of the Beccaguimic River, N.B.
18. *Leptæna sericea ?* Sowerby. A large form similar to that which occurs in the Utica and Hudson River formations of Ontario, the Island of Montreal and vicinity. This *Leptæna* occurs in the limestone conglomerate bands, which are interstratified or dovetailed in the black bituminous graptolitic shales, and the association of species at this place is totally different from that met with in the localities above mentioned.
19. A small brachiopod with broad hinge line, semicircular outline, elevated beak, flattened anterior margin, and sides with thread-like radiating striæ, and still finer, crowded concentric lines.

20. *Illænus*, sp. A nearly entire cephalic shield of a species of this genus, which appears to be undescribed, occurs in the pebbles of the limestone conglomerate. The glabella is nearly square in general outline, rather abruptly rounded anteriorly and apparently broadly rounded in front, rather gently convex, bearing a small tubercle a little in advance of the neck furrow. The species bears a considerable resemblance to Barrande's *Illænus Bouchardi*, but may be distinct from it and from other species recorded from Canada.

21. Pleura of a trilobite of doubtful generic reference, perhaps related to the genus *Illænus*.

22. *Hydrocephalus?* or perhaps a new genus. This collection contains a mould or impression of a diminutive trilobite, one-eighth of an inch in length, whose head and the remainder of the body are sub-equal. Cephalon rather strongly convex, semi-elliptical in outline, length and breadth sub-equal. Pygidium very small, semi-circular; body made up of five thoracic segments, which are apparently destitute of spines and tubercles, and decreases in size from the head to the pygidium. It was first referred to *Æglina*, but subsequent investigation led to its separation from that genus. It is here provisionally referred to the genus *Hydrocephalus*, but a better suite of specimens would no doubt reveal its true generic affinities.

23. *Cyphaspis?* or *Holometopus?* A very imperfect specimen. It occurs in a four-inch band of linguliferous limestone and is probably an undescribed species.

24, 25. Two species of entomostraca occur, associated with No. 23. One a large and rather conical form, probably a *Primitia*, and a smaller one, most likely a *Beyrichia*, with a deep sulcus posteriorly.

A subsequent collection from the same locality contain the following species:—

1. *Diplograptus Whitfieldi*, Hall.
2. *Crinoidal fragments.*
3. *Lingula*, sp. nov.
4. *Acrothele* (?), large form, n. sp.
5. " small do.
6. *Orthis*, sp. indt.
7. *Stricklandinia*, sp.

8. *Ampyx*, sp. (pygidium of).
9. *Trinucleus*, sp. (portion of ornamented border).
10. *Cheirurus* (?), sp. (portion of glabella).
11. *Asaphus*, sp. (pleuræ of large species).
12. *Bathyurus* (?), sp. (pygidium).
13. *Cyrtolites*, or allied genus of discoid gasteropod.

Cote d'Abraham.

The collection of fossils from Côte d'Abraham, in which are several monticuliporids, has also been examined by Mr. Ami. In it he also recognized :

1. *Orthis*, sp., cf. young specimen of *O. testudinaria*, Dalman.
2. *Leptæna sericea*, Sowerby.
3. *Asaphus*, sp., portions of pleura of a species of this genus.

Mr. Ami has also made a preliminary study of sections of a number of the monticuliporids.

Stratigraphical positions of the several conglomerates.

With reference to the fossils from the bands of limestone conglomerate, of which a very complete list has already been published in the Geology of Canada, 1863, it may be said that during the past two seasons good collections were made, not only from the beds about Lévis, but from several of the islands, from the Beaumont shore and as far down as Ste. Anne de la Pocatière, where the conglomerates are associated with the Sillery sandstones. From the lithological and fossiliferous character of the associated strata, it would appear that bands of conglomerate of several different horizons occur. Thus the beds of Lévis are intimately associated with the highly graptolitic shales of the Lévis formation, which we have found to constitute the upper part of the Quebec group, and overlie the red shales and sandstones of the Sillery. At Ste. Anne the conglomerates are associated with the Sillery sandstones as an integral part of the red shale series, and presumably belong to a lower horizon, as is also the case with the bands on Canoe Island and Grosse Isle, together with the other islands of the group. On the Beaumont shore, as at the contact above Cape Rouge, the beds of conglomerate are in the green and black shales, which contain thin, hard quartzose bands, the stratigraphical position of which is below the Sillery red shales, while in the city of Quebec the conglomerates are distinct from all these, and have a newer aspect, more properly belonging to the Trenton-Utica period, as proved by the character of the associated fossiliferous shales. While some of the fossils obtained from the limestone conglomerates, both of Lévis and other places along the shore to the east, have an undoubted Cambrian aspect, it may be

said here that, in so far at least as the collections made during the past season are concerned, all these Cambrian forms come from the pebbles and not from the paste. Thus at Fort No. 1, in rear of Lévis, pebbles of two pounds weight contained *Salterella*, but other pebbles from the same mass showed large Orthoceratites, with a diameter of two to three inches, while other pebbles again were well rounded pieces of an older limestone conglomerate. Limestone conglomerates.

In pebbles taken out of the conglomerates of the east end of Canoe Island the following species were found: Canoe Island.

Salterella pulchella, Billings.
Olenellus Thompsoni, Hall.
Microdiscus, sp.

The association of the conglomerates here is with red and green shales and hard sandstone of Sillery aspect.

From the conglomerates on the shore, midway between Beaumont and St. Joseph the pebbles yielded *Olenellus Thompsoni*, Hall, and *Olenoides* or *Microdiscus*, the associated rocks being green and black shales and hard quartzose sandstone. Beaumont shore.

From the pebbles in the conglomerates of Fort No. 3, in rear of St. Joseph de Lévis, were obtained:— Fort No. 3, Lévis.

1. *Salterella rugosa*, Billings.
2. *Orthoceras*, sp. like *Xerxes*, Billings.
3. *Cyrtoceras Syphax*, Billings.
4. " *Metellus*, Billings.

From the low ridge west of the high ridges which bound the Catholic Cemetery on the west, in rear of St. Joseph, were obtained: Lévis, near cemetery.

1. *Orthis Mycale*, Billings.
2. " *electra?* Billings.
3. *Camerella calcifera*, Billings, Lévis form.
4. " *polita*, Billings.
5. *Holopea*, sp. indt.
6. *Cyrtoceras Alethes*, Billings.
7. " ? sp. nov., (annulated).
8. *Bathyurus quadratus*, Billings; portion of head and body.
9. " *Saffordi*, Billings; several pygidia.
10. " *bituberculatus*, Billings: several heads.
11. " *Timon*, Billings; pygidium.
12. ? *Conocephalites Zenkeri*, Billings.

West end of Orleans Island.

From the west end of the Island of Orleans:

1. *Orthis apicalis*, Billings.
2. *Orthis*, sp. indt.
3. *Camerella polita*, Billings.
4. *Cyrtoceras*, sp. indt.
5. ? *Asaphus canalis*, Conrad; a nearly entire pygidium of a trilobite probably identical with this species.

Conclusions.

From a consideration of the many facts presented in the preceding pages in regard to the structure of the Lévis and Sillery divisions of the "Quebec group," a comparison can now readily be made with the rocks seen along the south side of the St. Lawrence to Cape Rosier, the description of which, east of Métis, was given in the Geological Survey Report of 1881-82. For although at that time it was strongly suspected that the true position of the Sillery formation was beneath the Lévis, it was held that, in view of the opinion which had prevailed for so many years to the contrary, it would not be wise to make such a change without the most convincing proof. This change in stratigraphy we now consider to be so thoroughly established, that but little, if any, doubt can exist on the subject; and upon this interpretation of the structure much of the difficulty which arose as to the correct understanding of the points stated in Prof. Lapworth's paper on the graptolites now disappears. From Métis to Cape Rosier the great bulk of the rocks, with the exception of the portion between Marsouin and a point about three miles below Griffin Cove, together with certain other limited areas clearly marked by characteristic fossils of an upper series, belongs to the Sillery formation, and much of it to the lower portion of that division, and entirely below what we regard as the fossiliferous or graptolitic Lévis formation of the city of Lévis and the south-west end of the Island of Orleans; and at only one point, viz., three miles above Ste. Anne des Monts, do we find what may be regarded as probably a Lévis zone. The rocks of Cape Rosier, in which the *Dictyonema sociale*, *Clonograptus*, etc., were found, as well as those two miles below Great Matane River, where similar forms occur, represent divisions 2 and 3 of the Cap Rouge section and the Beaumont shore, as well as of the the strata on the south side of the Island of Orleans, consisting of black, green and grey shales, with some red beds, together with the grey limestones and hard, greyish quartzites, while the associated limestone conglomerates are like those seen at Beaumont and at the east end of the Island of Orleans. This character is maintained with great uniformity for the entire distance west of Marsouin, though at certain points the Sillery sandstones and red and green shales representing division 4 are more highly developed

Sillery underlies the Lévis formation.

Rocks of the south side of the St. Lawrence to Cape Rosier.

than at others. The rocks of this section would, therefore, both on the evidence of Prof. Lapworth from the fossils, and from the comparison with the stratigraphical sequence of the Cape Rouge rocks, belong to a portion of the Cambrian system, probably representing the upper and middle divisions of that system, while the overlying Lévis graptolitic shales and limestone conglomerates would represent the lower portion of the Ordovician or Cambro-Silurian system. The lowest Cambrian would, therefore, come into its natural place upon the flanks of the pre-Cambrian ridges, which constitute the high lands of the interior anticlinal axis described in the preceding report and in subsequent pages of the present one. Cambrian age of the Sillery.

Three zones of conglomerate limestones can also be clearly defined, viz.: 1st, that associated with the green, black, grey and reddish or purple shales, in which the pebbles are very varied as regards size and character including sandstone, quartz and limestone trap; 2nd, that of Lévis proper, already well described; and, 3rd, that of the city of Quebec, which differs in character from each of the other two. In the pebbles of the first, *Olenellus Thompsoni* is found at various localities, and it is probable that the pebbles of conglomerate found in the conglomerates of the Lévis series are derived from these beds. Three zones of limestone conglomerate. Cambrian zone

From the conglomerates of zone 2, that of Lévis and the west end of the Island of Orleans, a much greater variety of fossils is obtained, including species which belong to a higher or later horizon, while their association with the Lévis graptolitic shales sufficiently indicates their stratigraphical position. In the same way, the interstratified position of the conglomerates of the Citadel hill, in Quebec, or zone 3, with the highly fossiliferous strata found at different places in the city, which present a distinctly newer aspect than the Lévis, fixes relatively the position of this zone. Lévis zone. Trenton-Utica zone.

The relations, or rather the exact horizon, of these Citadel rocks is still to some extent doubtful. Large collections of fossils were made during the past year, which show the presence of a fauna distinct in character and species from that found in the true Loraine or Utica formations, on the one hand, and from the Trenton or Chazy, on the other. The stratigraphical position of these beds does not afford much assistance in working out the problem, since while it may be safely asserted that they are closely related to the rocks which occur along the north side of the Gaspé peninsula, below the Marsouin, and on the north-west side of the Island of Orleans, which have long been regarded as of Utica or Hudson River age prior to the paper by Prof. Lapworth on this subject, there appears to be no palæontological evidence by which they could be definitely assigned to either of these Quebec city rocks.

Their stratigraphical relations.

horizons. They are brought by the great St. Lawrence and Champlain fault directly against the red, green and black shales of the Sillery formation, wherever seen on the Gaspé shore, as well as at Wolfe's Cove, below Sillery church, while on the Island of Orleans this fault brings them against the fossiliferous rocks of the lower part of the Lévis formation. In character of sediments also the rocks of the city of Quebec differ from those of the Utica in the fact that the former have a large development of bituminous limestone, while the latter in the vicinity are mostly brown, black and occasionally greyish shales, with only occasional bands of hard dolomitic limestone. They are equally different from much of the limestone of the Trenton as seen at Beauport, Lorette, etc. While the fossils are of species distinct from those of the formations just named, several of them, according to Prof. Lapworth, would seem to indicate the lower portion of the Trenton formation by their affinities, and some of the Monticuliporids collected during the past season have the aspect of the lower Trenton rather than of the Utica. It would, therefore, appear that these rocks are a peculiar development above the Lévis, and about the age of the Trenton formation, but the exact horizon of which, from the fossils yet obtained, is exceedingly difficult to determine.

Probable horizon indicated by their fossils.

In the list of fossils enumerated by Prof. Lapworth in his paper on the Graptolites, Trans. R. S. C., Sec. iv., 1886, a mistake has evidently been made in the labelling of some specimens which are said to be from a point half a mile above Cape Rouge. These fossils indicate beds of the Trenton-Utica or Marsouin zone, but no such strata are anywhere to be found in the vicinity of Cape Rouge, since from that village to the contact fault, nearly two miles above, the shore is occupied by the lower rocks of the Sillery or Cape Rouge Section, while above this for several miles the brownish-grey shales and greyish sandy beds of the Hudson River formation occur, similar to those seen on the south side of the river, about two miles south of St. Nicholas. This correction is deemed necessary in view of future explorations for fossils in this direction.

C. Cambrian.

Character.

The characters of the rocks which have for several years been regarded as constituting the Cambrian system of eastern Quebec are given with considerable detail in Rep. of Progress. 1877, Dr. Selwyn, pp. 5 A and 6 A, as well as in Annual Report, 1886, Part J, and the areas now under discussion are but extensions to the north-east of those there described. They consist for the most part of hard quartzites, often bluish-grey in color, veined in all directions with quartz, and

frequently containing an abundance of clear blebs of glassy quartz; they do not present the pebbly character so often seen in the beds of the Sillery formation, and they have occasionally a purplish shade and are interstratified with purple, greenish and black slates. A considerable area of green, sometimes schistose quartz-veined slate also occurs at several localities near the base of the series. At times the black slates, associated with the white or gray quartzite is finely micaceous, yet differing in character from the mica schists of the underlying system. These are well seen on the roads leading from the Craig Road to the several stations on the Quebec Central Railway. Limited outcrops of greyish sub-crystalline limestones are found occasionally in the first and second concessions north of Beauce Junction and in the township of Mailloux along the road leading north-east from the village of Buckland, and also near West Broughton. In all these places they are associated with the black slates and quartzites and have been burned for lime for local purposes.

Black slates and limestones.

The volcanic portion of the Cambrian, is also well developed in this direction, but is confined, for the most part, to the eastern side of the anticlinal. It is marked by the presence of frequent outcrops of trappean rocks, often concretionary in character and of greyish or reddish-brown colours. These rise into several lofty peaks, among the most conspicuous of which may be mentioned Broughton Mountain, on lot 25-26, range X and XI, of Broughton and Moose Mountain in the north-west part of the township of Cranbourne, to the north of the great bend of the River Etchemin, whence the volcanic rocks extend for some miles in a series of lofty ridges and hills to the north-east and south-west, though in the former direction, owing to the wilderness character of the country it was found impossible to outline this part of the series definitely. Serpentines also occur in connection with these rocks both massive and as agglomerates, though to a very limited extent as compared with their great development to the south-west. The large areas of serpentine rocks apparently extend northward no further than the township of Thetford. Small outcrops only occur on the Bras and Des Plantes branches of the Chaudière in Vaudreuil in connection with diorites which, in the form of dykes and bosses, form areas of considerable extent in this vicinity.

Volcanic portion.

North of the Chaudière the Cambrian rocks are divided, for some distance, into two portions by the ridge of Pre-Cambrian schists which marks the prolongation northward of the Sutton Mountain anticlinal, and which crosses the Chaudière in the vicinity of Beauce Junction. South of the river in St. Elzear and St. Frederic, these rocks, at times,apparently conceal the older schists nearly to the vicinity of St.

Chaudière and vicinity.

Severin, while further south, areas of Cambrian rocks form overlapping patches or closely infolded basins in the Pre-Cambrian. In Tring and Vaudreuil the Cambrian is concealed over a considerable area by the Cambro-Silurian rocks which extend north-east from Lake St. Francis while further to the east it is overlapped by the rocks of the eastern Cambro-Silurian area which continues thence to the boundary of Maine.

North of the Chaudière the western boundary of the lower Cambrian is somewhat difficult to trace, but it apparently follows a somewhat irregular line to the Etchemin being unconformably overlapped by the Sillery red slates, conglomerates and sandstones, the contact of the two series being near the village of Ste. Claire. Thence the line extends towards St. Lazare, crossing the road to Buckland near the Abenaquis River, beyond which the lower Cambrian quartzites and shales form the high ridge between St. Damiens and Buckland. Further to the north-east, the road leading from Armagh to Mailloux crosses the strike of these formations. Good sections of the Sillery sandstones and red and green shales are seen on this road for several miles southeast of Armagh Corner, being well exposed at the crossing of the Rivière du Sud, one mile and a half distant, where their folded structure is beautifully displayed. South of this stream the red and green shales are seen for two miles further, beyond which the Mailloux green and black altered slates of the Cambrian are found, though exposures are very rare, to the corner of the Taché road near Mailloux church. Further to the north-east, on the road south from St. Thomas, the northern limit of these rocks is seen about one mile north of the Taché road. Further east on this road, the line between these and the upper Sillery rocks crosses about three miles east of the village of St. Marcelle.

St. Lazare to Buckland.

Road south of St. Thomas.

Taché Road.

The Taché road extends north-easterly through the townships of Mailloux, Montmagny, Patton, Arago, Garneau, etc. South of this road the only settlements are St. Magloire in Roux, and St. Pamphile on the Elgin road, near the boundary of Maine.

Rolette.

The Cambrian rocks apparently conceal from view the schists of the underlying anticlinal, or lap completely round the northern extremity of the Pre-Cambrian ridge, which gradually declines in elevation in this direction, about the middle of range I, township of Rolette, a few miles south east of St. Paul de Buton, since no rocks of the older series are seen on the track which extends south-east past Lac au Crapaud, Cambrian and Cambro-Silurian sediments only being visible in this direction.

No fossils yet found.

Throughout the entire area of these lower Cambrian rocks no fossils have yet been found by anyone.

In lithological characters, part of these resemble, in many respects, those of the coast series of Nova Scotia, while in part they resemble

the lower portion of the Cambrian of New Brunswick. The most that can be said of them stratigraphically is that they are intermediate between the chloritic and micaceous schists of the central anticlinal and the overlying rocks of the Sillery, from which they differ considerably in character.

Resemblance to the Cambrian of New Brunswick.

Much of the strata just described, north of the Chaudière, were considered by Richardson in 1869 to be in part of Sillery age, and in part to belong to the Potsdam formation. While there is presumably a considerable interval separating the two horizons, as at that time understood, there are certain beds in both formations which possess many points of resemblance to each other. This question has, however, been pretty fully discussed in previous pages, and no further remarks are here necessary. It may, however, be added, that much of the confusion which has prevailed in regard to the true position of these rocks has been due to the apparent similarity and consequent grouping into one formation of all these sandstones and associated shales. On the old view as to the composition of the Sillery formation, it was quite correct to say that much of what was then so called was older than the Lévis, though it did not follow that all of what then was called Sillery should be placed in the same horizon.

Views of Richardson, 1869.

Considerable difficulty has been experienced in fixing the position of certain black slates which are closely associated with the chloritic and micaceous schists of the central anticlinal. While in places somewhat micaceous, they differ in character very considerably from the rocks which we have called Pre-Cambrian, and at certain points a manifest unconformity between the two series is evident. This is well seen on the road from Broughton station on the Quebec Central Railway to Harvey Hill, the regular strike of the underlying chloritic rocks being nearly east and west, where the overlying black slates, with which are associated beds of greyish limestone, at times strike nearly north and south. On this account, and because of the much greater metamorphism of the lower series, an attempt to separate them has been made; and while, in the absence of fossils which might be conclusive, no other evidence than that presented can now be adduced, this separation will serve to distinguish the crystalline schists which are often richly metalliferous, from the slaty series, which has as yet proved comparatively poor in this respect, if we except the quartz veins which may be, and presumably in many cases are, auriferous or carry argentiferous galena.

Black slates of the central area.

Concerning the Cambrian age of the serpentine belt, several of the remarks just made will also apply. The serpentines are apparently associated with two different groups of rocks; thus, certain areas are associated with great masses of concretionary as well as massive diorites,

Volcanic portion of the Cambrian

in which the latter largely predominate, as in the Moose Mountain and Etchemin districts. The associated rocks here are green, black and red slates with hard quartzites, which at first glance resemble some portions of the Sillery formation. Somewhat similar red slates also show near the Colway, on the Chaudière, where also diorite and serpentine in small outcrops are seen; near these, also, a small boss of granite occurs in the black shales.

Serpentines, diorites, etc.

Further south are the great serpentine areas of Thetford and Coleraine. The country rock is mostly a black or greenish slate with hard schistose quartzite, though at Coleraine station beds of dark red slates with conglomerates similar to those which flank the Stoke Mountain range, and which are described in the Report for 1886, occur, but which differ greatly in character from the crystalline schists of the central axis; while in connection with the chloritic and micaceous schists other areas of serpentine are found, generally of limited extent and frequently associated with talcose minerals, soapstone being often present. These are well seen in the Leeds district, north of Kinnears' mills where the rocks in which the serpentines occur are distinct in character from those seen in the productive asbestus district, as also from those in the township of Broughton. The manifest difference in the character of the strata, together with the fact of the occurrence of a great line of fault between the crystalline schists of the Sutton Mountain anticlinal, and the slates and serpentines to the east, are the chief reasons for the separation of these two series into Pre-Cambrian and Cambrian.

Economic importance of the Cambrian rocks.

The importance of these areas of Cambrian rocks, from an economic standpoint, has already been alluded to in the last Report, 1886, in connection with the gold and asbestus deposits of Eastern Quebec. The remarks then made have been fully sustained by the work of the past season, and it seems to be clearly established that the greater part at least of the gold, is derived from the quartz veins in this series of rocks. That these veins, which occur in great numbers in the slates and quartzites, are not uniformly auriferous, is no more than should reasonably be inferred, since the same feature is common to all gold regions; but it is probable that the greater richness of certain areas is due to the same principle that appears to be established now for the Nova Scotia auriferous leads, viz.: that the most productive veins occur along the axes of the anticlinals. This principle should apply both to the Chaudière and to the Ditton areas, since in the latter the most of the gold yet found is certainly derived from veins which are near the centre of the anticlinal axis in that locality.

It is possible, also, in the Chaudière district, that the frequent outcrops of diorite seen about St. Francis, and for a few miles in either direction, may have had some favourable influence in determining the auriferous characterof this section.

A. B. PRE-CAMBRIAN.

Formerly regarded as Lauzon and Sillery.

Underlying the series just described are the rocks of the central anticlinal referred to this period, and already alluded to in former reports as constituting the oldest rocks of the Townships. In the report for 1869 by Mr. Richardson, they were described as belonging in part to the Sillery and in part to the Lauzon division of the Quebec group. The view was at that time held that these rocks were the extension of those seen in the Sutton Mountain range, while the structure was supposed to be the same, viz., an overturned synclinal.

Eastward extension of the crystalline schists.

The axis of the Sutton anticlinal has been traced carefully during the past season and found to extend with great regularity north-east from the townships of Wolfestown and Halifax, through Leeds to the Chaudière River, where it is seen in the cuttings of the railway along the south slope of the river valley, about one mile south of Beauce junction. Northward it is observed in the brook which crosses the road in rear of that place between the concessions of St. Joseph and L'Assomption, though the older rocks are concealed for several miles on either side of the river by the overlapping slates and quartzites of the Cambrian system just described. The ridges of chloritic schists again rise into prominence a short distance further to the north-east in the concession of St. Adolphe and extend thence in an unbroken line for nearly thirty-five miles, forming the high range of hills seen in Frampton, the eastern part of Buckland and the adjoining townships of Standon, Mailloux and Roux, beyond which the prominent elevations gradually sink and the older rocks disappear about midway in the western portion of the township of Rolette. The widest part of this area is in Standon where it has a breadth, north of the Etchemin, of nearly five miles. On the west side it is overlapped by the black, wrinkled slates and quartzites of the Cambrian, which are seen in places to rest upon the older schists in a nearly horizontal attitude, and on the east it is likewise overlapped by the volcanic portion of the same system.

Their occurrence in Gaspé.

Further to the north-east, in Patton, Talon, etc., though the anticlinal structure is maintained, none of the rocks of the crystalline schist series have been recognized, as far at least as the Temiscouata road. Between this point and Matapedia Lake the belt of country constituting the height of land, has not yet been fully examined, though prominent ridges occur; but east of that lake the old rocks come into view again and constitute the Shickshock range. This has been shewn on the map of the Gaspé Peninsula. See Geol. Surv. Rep. 1880-81-82.

Development south of the Chaudière.

To the south west of the Chaudière the Pre-Cambrian rocks are well seen in continuation of those already described as occurring in Chester and Wolfestown. Within the last few years several new roads have been made which connect the old Craig road with the stations of Black Lake, Thetford and Robinson, on the Quebec Central Railway, and these have afforded good facilities for determining the limit of the schists in this direction. It is probable that several folds occur in the older rocks of this section, some of which include limited areas of the overlying Cambrian, which, under the aspect of purple, black and green slates and quartzites, are seen to lie nearly flat upon the upturned edges of the schists at several points on the Thetford and Broughton roads, the difference in the direction of the strike and dip of the two series being at times well marked.

The area of the older chloritic and micaceous rocks which varies considerably in the townships of Halifax, Ireland, Inverness and Leeds, rapidly diminishes towards the Chaudière by the overlap of the Cambrian strata till it has a breadth of not more than one mile at the southern boundary of the township of Ste. Marie, beyond which point these older rocks are apparently entirely concealed. Areas of chloritic and talcose schists also occur in a ridge extending through the township of Thetford.

Among other lines of traverse crossing the crystalline rocks of this system three may be described as illustrating the anticlinal structure of the area south of the Chaudière. Of these the most southerly is on the road from Ste. Sophie, east of Somerset, to Halifax. On this road, after crossing the flat occupied by the graphitic black shales and limestones, the first rocks seen are green slates, sometimes dark colored and highly schistose, with a great quantity of quartz in irregular veins. They are much twisted, but have generally a high dip to the south-west. In many respects they resemble the Pre-Cambrian rocks of New Brunswick, and represent probably either a portion of that system or the lowest members of the Cambrian series. Thence for two miles the road rises rapidly over greenish schistose slates with an occasional purple-tinged band to near the top of the ridge where green chloritic and micaceous schists come in, the dip of the series for this portion being N.W. Thence alternations of chloritic and micaceous schists are seen along the crest of the ridge and down the eastern slope to the crossing of the brook, nearly two miles west of Halifax Corner, where a band of black mica slates, similar to the rocks in the vicinity of Wolfestown, crosses the road. Green micaceous schists, however, again come in and extend to the road from Halifax to Wolfestown, east of which, towards Black Lake, alternations of green schist and black wrinkled and sometimes micaceous

Lines of section Ste. Sophie to Halifax.

slates, which may represent infolded areas of Cambrian sediments, occur. A series of synclinals is seen in the area east of Halifax, but the structure of the main ridge, east of Ste. Sophie, is undoubtedly an anticlinal one.

The second line of section between Inverness Corners and the Thetford mines crosses the Craig road near Bullet Brook.

Inverness to Thetford Mines.

The beds of green and black striped shales, with limestone conglomerates, seen to the west of Inverness are directly underlaid by green and grey slates, which are cut by quartz veins near Inverness Corner; while two miles east of that place, at the jog in the road near Irving, the black, wrinkled, irony slates appear. None of these slates have the distinctly schistose character of the Pre-Cambrian, but about half a mile further on, where a road runs south to Bullet Brook, green chloritic and micaceous schists come in and form the entire ridge between this point and Craig road, a distance of two miles and a fourth. On the second part of this section, that east of the Craig road, the first rocks near Bullet Brook are twisted green, grey and black slates, containing quartz-veins, which have been opened at this place for copper. Crossing the brook on the road to Thetford, the road ascends rapidly over mica-schists, silvery-grey, green and chloritic. These occupy the entire extent of the ridge nearly to the beginning of the descent to Thetford, a distance of four miles, having a general dip of N. 15°–50° W. < 15°–30°. The axis of the anticlinal is well seen near the eastern summit of the ridge, about four miles and a-half west of the Quebec Central Railway at Thetford station. Near the summit a belt of black, wrinkled and slightly schistose slates crosses the road, with a breadth of nearly two miles, being succeeded by green chloritic and micaceous schists, which thence extend down the road leading to Thetford brook as far as the crossing on the line between lots 23 and 24, three-fourths of a mile west of the Thetford River. Thence the black and grey slates and hard quartzites which accompany the serpentines extend to that stream. In this section also the structure of the second ridge is a true anticlinal one, all the sediments lying to the east of the summit, dipping apparently to the south or south-east, while those to the west dip in the opposite direction. The position of the black, somewhat schistose slates, which are occasionally micaceous, is the same as further to the south about Wolfestown, where we have considered them as infolded areas in the older schists

St. Sylvester to Broughton.

The third section, between St. Sylvester and Broughton, exhibits a similar succession of rocks. Here the breadth of the crystalline schists is very much reduced. They are first met with at the foot of the steep hill on the road leading from Harvey Hill through the ranges of Handkerchief and St. Frederic, where the ridge of crystalline schists is

the most prominent feature in the country, and has a direct breadth of one mile and a-half. Between this hill and the brook east of St. Sylvester Corner, purple, black and green slates, with hard quartzites, are the principal rocks, and these rest directly upon the schistose series, the dip of both being north-west. The rocks which border the crystalline schists on the east are similar in character to those on the west, and are distinct in character from those of the main ridge.

Areas north of the Chaudière.

North of the Chaudière the section across the central ridge is from the usual series of black, green, grey, and occasionally purple slates, with hard quartz-veined quartzites on either side, across a central aréa of chloritic and micaceous schists, having a breadth of nearly four miles east of West Frampton, with a distinctly defined anticlinal structure near the summit of the ridge. To the south-west of this ridge, in the vicinity of Les Saintes Anges, the rocks seen on the several roads are micaceous black and grey slates and quartzites, with bands of dark-grey crystalline limestone. Similar rocks are seen in the cuttings on the Quebec Central Railway along the hill south of the Chaudière, and they have been regarded by us as representing possibly the lower portion of the Cambrian, though they may be a portion of the older series. The green chloritic schists appear in a small outcrop at a brook crossing the back-road about one mile north of Beauce junction.

Black and grey slates of Standon

It will be seen from the several sections here presented that the succession of the strata is tolerably uniform and that the central anticlinal axis in the schists is constant. The distribution to the north-east and the termination of the schists have already been described. There is, however, an apparently overlapping basin of slates of Cambrian aspect, which crosses the Etchemin River in the vicinity of Standon, and can be traced for some four or five miles to the south-west and north-east of that point. It has in no place a greater breadth than one mile, and generally is much narrower, the rocks comprising it being distinct in character from the crystalline series.

From a careful consideration of all the facts presented above, it appears conclusive that, not only on lithological grounds but stratigraphically, the divisions of the Eastern Townships rocks, as now given, can be clearly maintained, many sections having been studied and the relations of the several groups being the same throughout.

The apparent absence of fossils from the beds which are now considered Lower Cambrian is not to be taken as conclusive of their non-existence at some point, since as in the case of the Lower Cambrian of New Brunswick, where diligent search has been prosecuted for more than twenty years and immense collections of primordial fossils made, it is only very lately that organic remains have been detected

in the lowest beds. The metamorphic condition also of a great portion of the strata in the Townships might preclude the discovery of traces of organisms, and even as regards the fossiliferous portion of the Quebec group it is found that the fossils are confined to very limited areas, and that great thicknesses of strata are apparently entirely devoid of any sign of organic life.

Crystalline and Igneous Rocks.

Granites.—The areas of granite found in the limits of the north-east quarter sheet are, so far as now known, confined to two localities, the great masses which form such conspicuous features in the south-eastern portion of the province, not extending so far northward. Of these granites a very limited outcrop is seen about half a mile south of the Chaudière River and about one mile east of the Bras du Sud-Ouest in Beauce. The other is found in connection with large masses of white granulitic rock which form an important feature in the serpentine areas of Coleraine, and Thetford, where the rock, which consists generally of felspar and quartz, at times contains mica. Between Black Lake station and Thetford mines on the Q. C. Railway, these white masses are very conspicuous, forming hills from half a mile to two miles east of the railway. In some of the asbestus workings, dykes of this rock, from a few inches to several feet in thickness, are seen to cut the serpentine and, at times, appear to have shattered the rock in contact, thus leading to the belief that the granulite is a newer rock than the serpentine.

Outcrop near the Chaudière.

Outcrops in Coleraine and Thetford.

Diorites are somewhat largely developed in this section as well as in that to the south-west. The continuation of the peculiar chain of peaks which extends from the Vermont boundary south of Owl's Head through Orford and Ham mountains into Adstock, is seen in the Broughton Mountain, and again on the north side of the Chaudière in the great mass of the Moose Mountain range and in several peaks to the north-east of it, not designated by special names. These rocks, as stated in Part J, Annual Report, 1886, are closely associated with the serpentine, of portions of which the latter may be and probably is an alteration, and in the serpentine areas of Thetford and Coleraine great masses of diorite rock both massive and concretionary are found. On the Chaudière also, between the Colway and the Gilbert, considerable outcrops of dioritic rocks occur, generally of greenish or greyish shades but, at times, as on the Colway of brownish color. The most extensive of all these is the mass in Cranbourne, known as Moose Mountain, which has been outlined over an area ten miles in length and two miles and a-half in breadth but its northern boundary has not been reached, owing to the densely

Chain of diorite hills.

Outcrops on the Chaudière.

Moose Mountains.

wooded character of the country in this direction, but it probably extends for several miles further. The areas on the Chaudière are generally of small extent, and often occur in connection with hard quartzose sandstone and black slates which are cut by quartz veins. At times these diorites are highly serpentinous, and form a serpentino-dioritic agglomerate. All these rocks belong to what is now regarded as a portion of the Cambrian system.

Diabase associated with the Sillery rocks.

Other masses of trap rock, mostly diabases, are found associated with the Sillery formation. These are greenish and brownish, and are, at times, amygdaloidal While they are quite numerous, probably the largest and most important are, 1st, near St. Apollinaire, five miles east of St. Antoine de Tilly, and not far from the line of fault between the Sillery and the Hudson River formations; 2nd, an area of considerable size whose southern limit is seen on the road from St. Gervais to St. Lazare, whence it extends to the north in a series of outcrops some of which are of large extent, for four miles to the vicinity of and beyond St. Nerée, and 3rd, a prominent hill on the road leading from the St. Henry and Anselme road to St. Gervais. These traps have exercised an apparent metamorphic action on the slates with which they are in contact, and in all the three localities, bands of slate and sandstone are intimately mixed with the trappean rocks. Small areas of similar rocks also occur with the black graphitic limestones and slates near Somerset and Ste. Julie

Their principal development.

Serpentines.—The areas of those rocks are often of considerable size and great economic value. The largest extends from the road leading from Coleraine to Wolfestown, through Coleraine into Thetford, and is the continuation of the belt described in Part J, Annual Report, 1886, as occurring in Ham and Wolfestown. The largest development is in the northern part of Coleraine about Black Lake and in the portion of Ireland adjoining, and it is in its northern prolongation into Thetford, where it forms a belt east of the Thetford River, that the valuable deposits of asbestus occur which are known as the Thetford mines. The economic importance of this belt was discussed in the last Report, but during the past two years a great amount of exploratory work has been done by various parties to determine the existence of workable veins of asbestus, and many new outcrops have been found, which may be briefly mentioned.

Economic importance.

Observations by Mr. Obalski.

The main ridge which extends north-east from Coleraine forms a very prominent mass along the west side of the Q. C. Railway as far as Black Lake where the most northern peak, known as Silver Mountain, rises on the south-west side of that sheet of water to a height by aneroid of about 500 feet above its surface. The belt has a breadth of two miles and a-half with its western limit in lot 24, ranges I to IV Ire-

land. The elevations of this ridge were not taken by us, but on a plan by Mr. Obalski, mining engineer for the province of Quebec, several prominent peaks are noted as rising from 600 to 650 feet above the lake. In this great mass of serpentine but two deposits of asbestus of sufficient importance to warrant mining, are yet known, viz., that owned by Fenwick and Sclater of Montreal, which is on the extreme south-east corner of the mass at a distance by road of one mile and a-half from Coleraine station, and the other, owned by King Bros., of Quebec, on lots 24 and 25, range III, Ireland. On Silver mountain, however, a number of small veins of asbestus have been observed, but no attempt has yet been made to develop them.

Coleraine and Ireland.

Black Lake.

This area of serpentine is bounded on the east by a ridge of diorite which extends to the small lake above Black Lake, opposite which the serpentine of the main mass crosses the stream flowing into that lake and shews in small cuttings on the railway as far as Black Lake station. The country along the Q. C. Railway for several miles north of Coleraine station is thickly strewed with serpentine boulders, but ledges rarely appear.

Black Lake to Thetford Mines

The main mass of serpentine is cut off at the shore of Black Lake, but re-appears on the north side and between the lake and the railway. West of the Thetford River it has not been seen except at one point on the road a short distance beyond that stream, where a mass of the rock occurs, but has the appearance rather of a large boulder than of a ledge. The northern line of the main belt crosses the railway a short distance north of Black Lake station and continues north-eastward with some breaks, showing diorite and granulite to the Poudrier road, which is now, for the most part of its length, merely a track largely overgrown. This road is nearly midway between Black Lake and Thetford stations. In the area lying between the railway and the Thetford River, towards the Thetford mines, diorites are occasionally seen, and several cuttings are made in the serpentine along the line of the track in this direction, but the great mass of asbestus bearing rocks keeps to the south-east of the railway towards Caribou Lake.

Thetford Mines

Near the boundary of the township of Thetford, serpentine comes in again to the west of the railway, and some rich ground is seen between it and the river, and passing into Thetford, it occupies the entire space between the river and the mines for a distance of half a mile or more, much of the surface being covered with drift so that the character of the underlying rock can only be determined by excavation.

Thetford and Black Lake road.

A waggon road has lately been made between Black Lake and Thetford, and thence alongside the railway to Robertson station. Between the two former places it rises steeply over serpentine for a mile to near the foot of a lofty ridge, on which Reid's, now Wertheim's,

Old Poudrier road.

mine is situated, whence it keeps more northerly and crosses the old Poudrier road, about one mile south-east of the railway. On this latter track the serpentine shews for several miles, the lots having been taken up by different parties as far back as lot 17, range A and B, two miles from the crossing of the Thetford road, beyond which the country is said to be swampy, and rock exposures rare. In this direction the masses of white granulite form very conspicuous features and occupy a very considerable area. At Thetford the largest of these is seen near the road leading from the Thetford mines to Ireland; west of the Thetford River no traces of serpentine were observed; slates and hard sandstones being the principal rocks till the schists of the mountain ridge are reached.

Granulite.

Area of serpentine noted by Mr. Obalski.

The principal area of serpentine extends north-eastward from Thetford station on the east side of the railway for about one mile, beyond which it disappears; but from the notes which Mr. Obalski has kindly furnished us of his exploration, it comes in again farther to the east. Mr. Obalski says:—"In Thetford township I found serpentine on lots 10, 11, range VII; lots 14, 15, 16, range VIII; 14, 15, range IX; 5, 7, 9, 10, range X; as also in Adstock on the Coldstream River, at the end of the Poudrier road."

Little Lake St. Francis.

Mr. Obalski also spent some days exploring the country in the vicinity of Little Lake St. Francis. He says:—"On the north-east side of this lake I noticed a belt of serpentine, three-fourths of a mile wide, running north-easterly; as also near a lake without a name, near the Poudrier road. Much of this resembles the Wolfestown serpentine, but other portions were light-colored and siliceous."

Thetford to Broughton.

On the north side of the railway, in the township of Thetford, serpentine occurs in lots 16, 17, 18, range IV, containing chromic iron; and small mounds of the rock occur also on lot 13, range V; and in range XI, Broughton, along the south side of the road from Broughton station to Harvey Hill, frequent outcrops of serpentine and soapstone are seen. These were mapped some years ago by Mr. H. Y. L. Brown, but no asbestus of economic importance has yet been reported from these latter areas. Further to the north-east, serpentine and soapstone occur on lot 14, range VII, on which the Broughton mine is situated. This is the most easterly outcrop of the belt known on the north side of the railway.

Broughton.

Chaudière district.

In the Chaudière district, serpentine occurs in three bands, separated by hard quartzites and black and grey slates on lot 13, range I, Tring, in which several small veins of asbestus were seen. Also on the Bras du Sud-Ouest, at the falls, three miles from the mouth, and in small knolls on the hill side east of that stream, and half a mile south of the Chaudière. On the Des Plantes it is seen in a hill and in the stream,

with slates and sandstones, just above the road across the mouth of the river, and further up at the Falls from one to two miles above. The outcrops at both these places are not large, but small veins of asbestus were observed. Small openings have been made to test them, although not much work has yet been done.

Cranbourne.

Beyond this, to the north-east, a small outcrop of serpentine is found in the east flank of Moose Mountain, on lot 23, range V, Cranbourne, on the west bank of the Etchemin, owned by Mr. Mangan. Here veins of asbestus up to five-eighths of an inch were seen. No serpentine was observed by us to the north of this point, but Mr. McOuat reports three small outcrops of serpentine rock on the old track, now entirely grown up, leading past Lac au Crapaud; one in range IV, Rolette, the others on range VI, Talon. The country in this direction is a densely wooded wilderness.

Ste. Catherine. Fahey's mine.

Among other localities observed by us may be mentioned an outcrop on the concession of Ste. Catherine, near the road, four miles east of St. Sylvester Corner, owned by Mr. Fahey, of that place, near the contact of schists and crystalline dolomites, with black and grey slates. This, in so far as we could see, contained but slight traces of asbestus. To the south-west in the township of Leeds, on the road north from Kinnear's Mills, and on lots 1, 2 and 3, range X, several small areas occur; but from none of these has workable asbestus been reported, though good chromic iron was found there, and several beds of very rich magnetic iron ore occur in the vicinity. Also on range XV, of Leeds, about two miles south-west of Harvey Hill, Mr. Richardson reports several small areas of serpentine and soapstone. These, also, have not yet produced asbestus in workable quantity.

Leeds.

Difference in character of the serpentine.

The character of the serpentine in these small detached areas outside of the main mass of Thetford and Coleraine is generally uniform, but differs somewhat from that in the mining districts. It is often softer and has a peculiar talcose shade and unctuous aspect, and is frequently associated with soapstone, a mixture not found at any of the quarries now worked, with the exception of the mine at East Broughton, where the workable asbestus, in so far as yet known, is confined to a single vein at the contact of the slates and quartzite with the serpentine, and which has now been worked to a depth of over 60 feet. In the lower portion of this working, soapstone of fine quality was met with, which in places forms the hanging wall of the main vein of asbestus.

SURFACE GEOLOGY.

The features of the surface geology to which attention was specially directed during the past two years had reference to the course of the ice-flow and the distribution of boulders and other drift. The great valley of the St. Lawrence, which in pre-glacial times must have extended from twenty-five to forty miles east of its present channel, is clearly defined by the prominent ridge of Cambrian and Pre-Cambrian rocks, and must have been of considerable antiquity. The same was probably true of many of the side streams, such as the Etchemin, the Chaudière, etc., whose pre-glacial character is clearly proved by the finding of old channels flowing into the main river, which have been filled with gravel and sand prior to the deposition of the boulder-clay.

Pre-glacial valley of the St. Lawrence.

Character of surface.

Throughout the entire area great deposits of clay and sand are found. These are especially noted in the broad, flat country lying to the east of the St. Lawrence, over which the line of the Grand Trunk Railway passes, and where large areas of peat bogs occur. In some of the river sections thick deposits of clay are found, which have a depth of many feet, but most of these are devoid, in so far as could be seen, of marine shells, which were observed at but very few points, though this area must have been submerged for several hundred feet.

Throughout this great area exposures of rock are comparatively few. Occasionally a low ridge of hard sandstone and slate appears above the surface. The river channels sometimes show fair rock sections, as on the Becancour and elsewhere, but the smaller streams do not appear to have cut through the drift in many places to the underlying rock. The surface of the country rises very gradually, after reaching the crest of the cliffs which overlook the St. Lawrence, the elevation of Fort No. 2, in rear of Lévis, being, by aneroid, 350 feet above the river, while at Beauce Junction the elevation is only about 100 feet higher. The Pre-Cambrian ridges rise abruptly, and at Harvey Hill have elevations of 1400 to 1600 feet, while the ranges of the Buckland hills have probably not far from the same height. On the east side of these ridges the country slopes gradually to the great basin of the St. John River waters, which is near the eastern limit of the province, and which, when seen from the highlands to the west, looks like a great flat or slightly undulating and thickly wooded plain, analogous to the St. Lawrence basin.

Surface elevation.

The theory proposed several years ago of local glaciers, instead of a great ice-cap, seems to be sustained by the observations of the past two years in the country lying to the south of the St. Lawrence. Striæ are not numerous, but where seen have a generally westerly course on

the west side of the main ridge, trending on the low lands towards a south-westerly or north-easterly direction along the valley of the St. Lawrence, while on the east side of the ridge the course of the striæ indicates a motion to the north-east into the upper branches of the St. John River. As a general rule, the markings, where river-valleys exist, follow the course of these. The following list from places pretty wide apart may be given:—

S. 55° W. on second Con. road, between St. Gervais and St. Raphael midway. Striæ.
N. 80° W. on second Con. road, one mile east of St. Raphael.
N. 85° W. on fourth Con. road, near St. Nerée Church.
N. 85° W. on road to Armagh, 2½ m. N.-E. of St. Lazare.
N. 75° W. on road ¾ mile south of Armagh Church.
N. 50° W. on road 2½ m. S.-E. of Ste. Agathe.
N. 40° W. on same road, one mile west of Craig Road.
N. 35° W. cor. of road, five miles west of Tring.
S., on east side of West Frampton Ridge, also on top of ridge.
N. 60° W. on road from Frampton to Ste. Henedine.
S. 35° E. on ridge S.-E. of Frampton.
N. 80° W. near Ste. Sylvester.
S., at cor. of road near Lake Etchemin.
N. 65° E. St. Justin Church.
N. 20° E. crossing of Becancour River, one mile east of Campbell's corner, Inverness.
S. 55° W. road St. Anselme to St. Gervais.
S. 35° W. road from St. Gervais to Ste. Claire, R. VIII, Martinière.

In many of these cases the connection between the course of the striæ and the old river valley is very plain. Though areas of sand, gravel, and clay are numerous, well defined kames are rare, the most conspicuous seen by us being on the road from Leeds village to Kinnear's mills, about a fourth of a mile north of the Osgoode River; the direction of this kame is generally parallel to the course of the stream or N. 5° E. It has a length well defined of over half a mile, with an elevation of thirty feet. Kames.

Among the most interesting surface features in this section is the presence of scattered boulders of Laurentian rocks, gneiss, labradorite, limestones, etc. These in the valley and along the hill-sides of the Chaudière are so abundant that they have been used for building the church at St. Joseph, and the great variety of Laurentian rocks in this structure is an interesting geological study in itself. The elevation of the locality from which these boulders were obtained is from 450 to 600 feet above the St. Lawrence. But further inland similar boulders occur, not only in the approximately level country of the Cambrian to the east of the central axis along the line of the Quebec Central Railway, but even on the most elevated ground, as at Drift Laurentian boulders inland.

Harvey Hill, which is calculated, by barometer, to have an elevation of about 1,500 feet. Along the slopes of the hills in this vicinity scattered pieces, both large and small, of well rounded true Laurentian gneiss occur, the source of which could have been no other than the rocks along the north side of the St. Lawrence. It is difficult to conceive, either on the theory of local glaciers or on that of a great ice sheet, how these scattered boulders could have been deposited on the high lands of the interior, since on the former hypothesis the local glacier could have had no connection with the source of the boulders and on the latter the ice markings indicate that the course of the glacier could not have carried boulders from the hills along the north side of the St. Lawrence, across the great valley of that river, to the crest of the opposite ridges 1,500 feet or more above sea level.

Theory of their distribution.

The alternative theory to account for their present position must be one of submergence and floating ice, just as we see at the present day, the transportaion of loose stones going on from the north to the south side of the St. Lawrence by the agency of great ice-pans, which, freezing along the shore and around the beach stones, are borne away by the tide and subsequently stranded often at distances far remote. A beautiful illustration of this is seen along the shore between Cape Rouge and Point au Platon. Along this portion of the river, more particularly on the north side, but also on the south side above St. Croix, there is a series of shallow bays with great flats, bare at low tide and extending out for nearly a mile from the shore. These flats are thickly strewn with boulders of Laurentian rock, while the points which divide the bays are in nearly every case entirely composed of boulders. These have been undoubtedly left in their present position by the action of floating ice carried along by tide and wind, and stranded in these coves precisely in the same way as timber rafts, when descending the river, if they meet a strong north-east wind below Point au Platon, are driven on shore and frequently broken up. It is, therefore, quite conceivable on the supposition of a submergence sufficient to nearly cover the hill ranges of the interior, that the scattered boulders there observed were deposited by the same agency.

Remarks of Mr. A. Webster.

The distribution of the gold in the drift, for the country south of the Chaudière, was given in last report. In connection with the question of submergence the observations of Mr. A. Webster may be noted. He says "the drift appears to come from the north-east, and is found overlying a bluish-grey boulder clay, in which no gold has been observed. The gold drift contains fragments of local rocks and foreign boulders of Laurentian and newer formations;" and again, "The altitude of the gold-bearing drift appears nowhere to exceed 2,000 feet above the sea. Below this height colors of gold may be said to occur anywhere to the

south-east of the great Quebec anticlinal and most abundantly on the upper waters of the Chaudière and St. Francis rivers. It has also been found on the Maine water-shed." Mr. Webster also remarks that "On the St. John and Daaquam rivers, to the north east, no gold was found, though carefully looked for. This may be owing to the swampy nature of the country and the few exposures of bed rock."*

It is, however, probable that the gold-bearing rocks of the southern area are concealed in this direction by the overlap of the Cambro-Silurian sediments already described. From the remarks in Geol. Can., 1863, p. 929, as to the phenomena observed about Lake Memphremagog and on the sides of the mountains in northern Vermont and New Hampshire, the theory of a submergence of this portion of Quebec to a very considerable depth is clearly stated. The occurrence of clay terraces at the upper end of that lake, 778 feet above sea level, with successive terraces of sand and gravel, to a further height of 579 feet, is noted, while it is further stated, *op. cit.*, "similar stratified deposits form a regular terrace-like beach in Ripton on the Green Mountains at a height of 2,196 feet. Ancient beaches are described by Dr. Hitchcock as existing in the White Mountains at elevations of 2,449 and 2,665 feet above the sea." Evidences of submergence, Geol. Can. 1863.

Economic Minerals.

Gold.—The history of the gold industry in the Chaudière district was given in the last report, and but little further can be said on the subject. During the last two years work has been carried on by four companies, with, so far as could be learned, satisfactory results. Part of this work was largely of an exploratory character. Of these companies, the works of McArthur, Copal & Co. operating near the village of St. Francis, Beauce, are the most extensive. They are situated at Meul Brook, a branch of Mill Creek, about half a-mile from the mouth and to the south of the village. Prospecting for an old river-channel has been going on at this place for several years, but two years ago the ancient bed of the Meul stream was struck, and had been tunnelled by the end of 1888 to a distance of over 600 feet, openings being made for ventilation and the easier working of the mine. At the time of my visit, in September of that year, the end of the tunnel at 400 feet, was thirty feet lower than the present bed of the stream, which was about sixty yards to the east. Great difficulty was encountered in sinking, owing to the quantity of quicksand encountered. The bottom of the old channel contained a good deposit of well-rounded, worn gravel, cemented with sand and clay, from which nuggets of gold from $10 to $153 in

Gold mining on the Chaudière River.

St. Francis, McArthur, Copal & Co.

* Rep. Prog., 1880-81-82, p. 4 A.

value had been reported. Difficulty in washing the gravel in order to save the fine gold was experienced, the system of sluicing not being properly arranged as regards fall and other appliances necessary for obtaining the best results. The returns of the quantity of gold produced from this mine are unfortunately not to hand for publication.

Des Plantes River. H. Sewell.

At the Des Plantes, Mr. Horace Sewell, in connection with Montreal parties, has been engaged during the last two years in locating the old river-channel of that stream. During the last year a shaft was sunk on the east side of the river, about half a-mile above the road and a short distance below the old workings of Mr. Mackenzie. The bed rock was reached at a depth of thirty feet, and consisted of sandstones, slates and diorites, overlaid by about four feet of well-worn river gravel, cemented with clay and sand. This is now being followed, and coarse gold in paying quantity is reported. The Des Plantes, in the earlier days of gold mining in this section, produced a large amount of coarse gold.

Cumberland stream, Capt. Richards.

On the Cumberland stream Capt. Richards has continued his exploratory work, but when the last returns were received at the close of the season, had not apparently succeeded in striking the old channel in that quarter. No returns of output are available, but, in so far as could be learned, very little coarse gold was obtained.

Famine River. St. Onge Bros.

The fourth company was working on the east bank of the Famine River, about one mile above the bridge across the mouth of the stream. The former workings of the St. Onge Company having proved unprofitable from several causes, a drift was started in the bank of the Famine by two of the St. Onge brothers, which has penetrated what the miners regarded as another channel in gravel carrying gold, the richness of which has not yet been learned. No attempt has yet been made to work the quartz reefs of the Chaudière district. An analysis of a piece of quartz from lot 12, range I, north-east St. Francis, was made last year by Mr. Hoffmann, who obtained .117 of an ounce to the ton of 2000 lbs., showing the auriferous character of the vein. It is doubtful if the Cambrian gold-bearing rocks appear very far to the north-east beyond Cranbourne, being probably concealed by the over-lapping Cambro-Silurian; but quartz-veins, which look well and which, from analyses made by assayers at various places in the United States, have shown a good amount of gold, occur near the road leading from St. Francis village to Cranbourne, about four miles from the former place.

Harvey Hill Mines.

Copper.—The indications of copper are quite numerous in the section south of the Chaudière, but north of that stream are very slight. The most important of these, from a historic and commercial standpoint, are the celebrated mines of Harvey Hill, which were worked very

extensively some twenty years ago, but have been idle during the last ten or twelve years. Lately, however, the property has changed hands, and a company has been organized, which has begun a thorough exploration of the mines, old levels are being extended and new ones driven. A considerable quantity of good ore, much of which is of high grade, has been shipped during the last three months, but no facts which have not already been mentioned in the reports of the Geological Survey have come to light. As much attention has of late been directed to the occurrence of copper in this portion of the townships, the following list of localities, published by Mr. Richardson in the Report for 1866, but which is not generally available, may be reproduced here :—

Halifax.

List of copper localities—Halifax.

Range.	*Lot.*	
1	10	Green carbonate in dolomite and yellow sulphuret; in white quartz in chloritic slate in another place on the list.
3	10	Yellow, variegated and vitreous sulphurets, with green carbonate and black and red oxyds in a gangue of quartz calcspar and brown spar of from eight inches to three feet, running with the stratification in chloritic slate, which holds specular and titaniferous iron ore. This is the *Halifax Mine* (Geology of Canada, 1863, p. 724), in which considerable work has been done by adits and shafts. In a quartz-vein cut by an adit a small quantity of gold was obtained. Land belongs to *Celeste Dubois*.
3	16	Yellow and variegated sulphurets in nacreous slates.
3	18	Green carbonate in black slate.
5	6	Green carbonate in white quartz, with calcspar in nacreous slate.
6	6	Green carbonate in chloritic and nacreous slate.
7	5	Yellow and variegated sulphurets in white quartz, with chloritic in chloritic slate. *Théophile Girouard.*
7	6	Yellow sulphuret in a quartz-vein in dolomitic limestone. *Megantic Mining Company.*
7	9	Green carbonate in white quartz in chloritic and epidotic slate, with granular magnetite.
8	9	Yellow and variegated sulphurets in dolomite. *Black Lake Mine.* (See range 9, lot 9.)
10	5	Yellow, variegated and vitreous sulphurets.
10	10	Yellow, variegated and vitreous sulphuret
10	11	Yellow, variegated and vitreous sulphuret.
11	5	Yellow sulphuret.
11	6	Yellow sulphuret.
11	11	Yellow, variegated and vitreous sulphuret.
11	12	Yellow, variegated and vitreous sulphuret.
11	12	Variegated sulphuret in a two-foot vein of quartz.
11	13	Yellow, variegated and vitreous sulphuret.

	11	20	Yellow, variegated and vitreous sulphuret. *Canada Mining Co.*
	12	10	Yellow, variegated and vitreous sulphuret.
	12	11	Yellow, variegated and vitreous sulphuret.
	12	13	Yellow, variegated and vitreous sulphuret.
	12	18	Vitreous and variegated sulphuret and green carbonate in quartz courses in nacreous slates. — *Ryan.*
	13	16	Yellow, variegated and vitreous sulphuret in nacreous slates. *English and Canadian Mining Company.*
	13	17	Yellow, variegated and vitreous sulphuret in nacreous slates. *English and Canadian Mining Company.*
	14	13	Yellow, variegated and vitreous sulphuret.
	14	14	Yellow, variegated and vitreous sulphuret.
	14	15	Yellow, variegated and vitreous sulphuret.
		16	Yellow, variegated and vitreous sulphuret and green carbonates in a vein with quartz, bitter spar, chlorite, steatite, specular iron, and a little native gold. (Geology of Canada, p. 730.) *English and Canadian Mining Company;* land to — *Nutbrown.*
	15	16	Yellow, variegated and vitreous sulphuret in nacreous slates. *English and Canadian Mining Company.*
		17	Yellow, variegated and vitreous sulphuret in nine quartz courses and three beds of nacreous slates. *Harvey Hill Mine. English and Canadian Mining Company.* (Geology of Canada, 1863, pp. 724-729.)
		18	Yellow, variegated and vitreous sulphurets. *English and Canadian Mining Company.*
	20	19	Yellow, variegated and vitreous sulphurets. *Canada Mining Company.*
	9	4	Variegated sulphurets.
		6	Variegated sulphurets.
		9	Yellow and variegated sulphurets in dolomite and slate. On this and on the same numbered lot in range 8 is situated the *Black Lake Mine,* in which considerable exploratory work has been done. *Dr. James Reid and others.*
	11	6	Variegated and vitreous sulphurets in nacreous slate. *W. W. Stuart.*
		7	Variegated sulphuret in dolomitic limestone. *A. G. Woodward.*
		12	Green carbonate in white quartz in chloritic slate.
Ireland.			*Ireland.*
	I	3	Green carbonate in white quartz in chloritic slate, associated with dolomite.
	9	9	Green sulphuret in dolomitic limestone.
	11	4	Variegated sulphuret. — *Bailey.*
Inverness.			*Inverness.*
	1	7	Variegated and vitreous sulphuret in nacreous slate. *W. W. Stewart.*
	2	4	Variegated sulphuret in a two-foot vein of quartz in nacreous slate. *Megantic Mining Company.*

	19	Green carbonate in flakes in strings of quartz cutting micaceo-chloritic slate.	
3	22	Green carbonate in flakes in strings of quartz cutting chloritic slate.	
4	2	Yellow sulphuret in dolomitic limestone.	
	4	Variegated and vitreous sulphurets in nacreous slate. *Angus McKillop.*	
6	9	Variegated and vitreous sulphurets in nacreous slate. *Jos. Steele.*	
	14	Yellow and variegated sulphuret disseminated in three quartz-veins of from one to two feet thick, running with the stratification in nacreous slate.	
11	23	Green carbonates in dioritic slates on the River Becancour.	

Leeds. Leeds.

2	6	Variegated sulphuret. — *Harris.*
4	4	Yellow sulphuret in dolomitic lime-tone. — *Ewart.*
9	8	Green carbonate in flakes in green chloritic sandstone
10	8	Yellow, variegated and vitreous sulphurets.

Copper is also reported by Dr. Reid as occurring in Leeds, range 15, lot 14; also on lot 5, range 5, and lot 4, range 9. These localities have not yet been examined by us, as the report came to hand after our return from field work.

Thetford. Thetford.

Range.	*Lot.*	
1	6	Green carbonate in green slate, resting on black slates, with cubes of iron pyrites.

Nelson. Nelson

11	8	Yellow and variegated sulphurets and green carbonate disseminated in diorite to a breadth of thirteen feet

Broughton. Broughton.

5	10	Variegated and vitreous sulphurets.
	12	Variegated and vitreous sulphurets.
4	13	Variegated and vitreous sulphurets.

Frampton. Frampton.

2	14	Green carbonate in grey limestone.

St. Giles Seigniory. St. Giles.

Ste. Marguerite, 1, 2, 3. Variegated and vitreous sulphurets and green carbonates in quartz courses in nacreous slates. — *Cromwell.*

Several other localities exist in the seigniories of St. Mary, Gaspé, Lauzon and Sillery, where indications of copper are found, sometimes in diorite, at others in limestone, sandstone, etc., which are described in the report of Mr. Richardson, quoted above. None of these appear, however, to be of any economic value, and the same may be said of most of those noted in the preceding list. The above are all the localities at present known to us where copper ore has been observed within the limits of the north-east quarter-sheet of the Quebec map.

Titanic ore of Colway River.

Iron Ore.—The beds of iron ore which occur in Leeds, near Kinnear's mills, have already been described in the previous report. In a former report a bed of titanic iron ore is described by Dr. Hunt as occurring on the Colway, with a breadth of between forty and fifty feet, but of late years no attention seems to have been paid to it, presumably on account of the high percentage of titanic acid.

Chromic iron.—Local deposits of this mineral occur in connection with the serpentines at several points. From the area in Leeds, near Kinnear's mills, about fifty tons were removed two years ago by Dr. Reed and found a ready sale at a fair price. Another deposit in Thetford, range IV, lots 16, 17, seems to have a considerable extent, but is probably of too low a grade to be suitable for the foreign market, though no analysis of it has yet been made.

Thetford.

Asbestus.—The Asbestus industry continues to be one of the most important in the province, and as the work of the last two years has, to a certain extent, embraced the leading areas where mining has been prosecuted, a brief *resumé* of its progress and development has been deemed advisable as a supplement to that which appeared in the last report.

First reference to asbestus.

Prior to 1862 the presence of asbestus was known in connection with the serpentines of the Eastern Townships, since at the London International Exhibition of that year a specimen of a vein from the Seigniory of St. Joseph was placed in the collections forwarded by the Geological Survey. (See Cat. 1862). Reference to its occurrence with chromic iron in various parts of the Eastern Townships and Gaspé is found in the Can. Nat. 1862, vol. vii. It was not, however, for some years, or till 1878, that its importance, from an economic standpoint, was discovered. Since then the growth of the industry has been very rapid. Within the last two years attempts have been made to unite under one management the mines of Thetford and Black Lake, but this scheme has been only partially successful. During the past year a company was organized in London by Mr. John Bell, which now owns the Thetford property, formerly known as the Boston Asbestus Company; the Bellmina area, worked for several years by Mr. Grey for Mr. John Bell, and the Hayden lot in north half of lots

27 and 28, Range B, Coleraine, now under the management of Mr. Carter, while Mr. Thos. Sheridan remains in charge of the Thetford area, and it is but fair to say that much of the success which has attended the operations of this company is due to the economy and skill with which he has developed the property at that place. In addition to the other mines operated at Thetford in 1886 or the date of the last report on this subject, viz.: King Bros., Johnston, Irving & Co., and Ross, Ward & Co., several new openings have been commenced. The Ward Bros. have located a new quarry to the west of the Quebec Central Railway, which has struck rich ground. Mr. A. H. Murphy, in lot 28, range V., uncovered a considerable space and disclosed some fine veins, while further west, or towards the river, King Bros. and Johnston have started several prospecting pits, in all of which the asbestus is visible, and the surface indications are very satisfactory. These several trials have proved very fairly the value of the serpentines lying between the railway and the river, and shew that the productive ground of Thetford is not confined to the mound in which the mines were all at first located. On the adjoining property of Lucke & Mitchell, lot 32, range C, Coleraine, although the excavations made several years ago disclosed good workable veins, nothing further has been done to develop it. It may be said that the operations of all the companies engaged at Thetford during the past two years have been eminently satisfactory, and although the bad weather of last season interfered to some extent with the output, yet the amount of asbestus mined was greater than in any previous year. An attempt was made at the Boston Company's mine by Mr. Sheridan to prove the rock at a lower depth, which was completely successful, and veins of beautiful silky mineral, up to three inches in length, were obtained from a further depth of thirty feet, the expenses of the shaft being much more than repaid by the quantity of asbestus removed. This trial shaft is satisfactory inasmuch as it probably proves the productiveness at deeper levels of all the adjacent mines. At King Bros.' mine, which had encountered a mass of comparatively poor rock, necessitating expensive cutting, the trouble has been overcome and very rich ground again found. The returns from the Johnston mine are not yet in, but it is known that work has also been satisfactory. At the Ward mine much delay arose towards the close of last season from the quantity of water in the quarry, due to springs and wet weather, which necessitated the placing of a pump, an expense from which the other mines are as yet apparently free; but though this latter mine is situated at a lower level than the others, the size and quality of the veins is in no way inferior. The output for the Bell Company's mine at Thetford for the past season to the 21st December

Thetford Mines

Output at Bell's Mine, Thetford.

was 1,350 tons, of which there were: Firsts, 930 tons; seconds, 105 tons; while the balance was thirds, or what is there called waste, in addition to a considerable quantity in stock and undressed. This mine has, during the past year, been fitted with air compressor and drills, while hoisting engines will probably be added during the coming season.

King Bros.' mine. From King Bros.' mine the output for the season of 1888 was 580 tons as follows: Firsts, 170 tons; seconds, 165 tons; thirds, 245 tons. In the township of Coleraine several new mines have been started, among which may be mentioned that of the Bell Company on north half lots 27-28, range B (formerly Hayden); lot 32, range B by Capt. Williams; and on the Quebec Central Railway, about one mile south of Black Lake station, by Loomis & Johnstone. From the first of these no returns are to hand, the work having been started late in the season, but an examination of the locality showed a great number of small veins on the surface at several points, while in the cut near the foot of one of the mounds fibre of fine quality in lengths from one and a half to two inches was disclosed. Several large masses of white granulite occur in this vicinity.

Black Lake mines.

From Capt. Williams' mine, lot 32, range B, the output to 1st of October was twenty-nine tons, of which four and a half were classed as *firsts*, and the rest about equally divided between *seconds* and *thirds*. Good veins were also seen on the surface on this property.

Reed's mines now Wertheims. The south half of lots 27-28, formerly belonging to Dr. Reed, but lately sold to the Wertheims, of Frankfort, Germany, is now being opened up, it being the intention of the new company to put in improved machinery with a view to economy of production. This property is the most elevated in the district, being not far from 600 feet above Black Lake station, and the surface indications are very favorable, veins up to two inches and a half being found in a series of cuttings along the crest of the hill. The fibre of much of the veins is soft and silky, shewing that the greater elevation of the area is not the cause of the stiffness or harshness seen at some localities. Dr. Reed states that prior to the sale about twelve tons were taken from this place, of which two tons were *firsts* four *seconds* and six *thirds*. This mine is now being worked by contract at $25 per ton, made ready for the market. On the north side of the Poudrier road in lots 27, 28, 29, Range A, Coleraine, several openings have been made in which good indications were found, veins up to one inch and a half, with many small ones being observed. Also on lot 26 an opening well up on the hill showed small veins of asbestus, and on Lot 23 the surface indications are very fair, though but little has been done in any of these lots to determine their real value.

Further to the east, about Little Lake St. Francis, though small veins occur, those seen, if fair samples, were of poor quality; the fibre being short and harsh. The present comparative inaccessibility of these more remote localities will seriously affect their value. In the southern part of Coleraine and in the south-east corner of the great ridge of serpentine which extends from Wolfestown road to Black Lake, work was begun or rather resumed by the Megantic Mining Co. Mining in this locality was started in 1886, and was noted in previous report as having disclosed a large vein of asbestus with fibre of four inches in length. This vein was not apparently persistent to any depth, the rock being greatly shattered near the surface and for some fifteen feet down, and though quite a number of veins, some of which, in the more solid rock, showed fibre of one inch and a-half in length, much of the asbestus is greatly discolored, owing to the broken character of the rock. A peculiar feature not noticed in any other place in this district is the presence of irregular veins of mica, in scales of half an inch or more in diameter, in a paste of decomposed serpentine or soapstone. It is probable that after passing the shattered ground good mineral will be found. The output for the four months of last season to Oct. with an average of twelve men was thirty-nine tons, of which one-third would rank as *second* and two-thirds as *third* quality. On the same ridge, but on the extreme west limit, on lots 24 and 25, range III, Ireland, King Bros. have started two openings. The elevation of these by aneroid above the surface of Black Lake is 500 feet or about 300 to 350 feet above the mines at Thetford. The two knolls in which the asbestus is found at this place are about one-fourth of a mile apart, and the fibre occurs in a series of thin veins from one-eighth of an inch to over an inch in size in places, as many as twenty being found in the space of six inches. Many of these veins shew a selvage of whitish weathering serpentine on either side, separated by a thin vein of asbestus from one-fourth to three-fourths of an inch thick. Other veins of good size, ranging in thickness to one inch and three-fourths, are numerous, the general aspect of the serpentine and contained veins being much like that of the great ridge in Wolfestown. The surface indications are excellent, but the property has not been sufficiently developed to form an estimate of its production, only two months work of a few men having been spent upon it.

Little Lake St. Francis.

Megantic Mining Co., Coleraine.

King Bros., Ireland.

In the Black Lake district proper the three established mines, viz., the Scottish-Canadian, the Anglo-Canadian and the D'Auville, have all been steadily at work. Mr. Penhale, the Manager of the Scottish-Canadian, states that in the eight months ending 10th Nov., 400 tons were shipped from that mine, of which 40 tons were *firsts*, 110 tons *seconds*, and 250 tons *thirds*, but operations were hindered by scarcity

Scottish Canadian mine.

Black Lake. of men and bad weather so that the projected new workings could not be carried on. This mine is equipped with improved machinery, air compresser, rock drills, hoisting engines, and dumping skips, and has a new set of appliances for crushing the rock, and separating the asbestus, more particularly in regard to the lower grades, to avoid the great expense of cobbing by hand. Although this machine was in operation but a short time, it is claimed by the manager to be a great success. Should this be the case and the asbestus of short fibre be easily separated, the profits of the industry will be largely increased; since many of the dumps, most of which now cover very valuable ground, can be profitably worked over, and the refuse disposed of for ballasting or other purposes while under the present system of hand cobbing, the shorter veins do not warrant the expense necessary for their separation. In this connection it may be remarked that the question of dumps is beginning to assume a somewhat serious aspect which will be aggravated as the production of the mines increases; since many of them will ultimately have to be removed, as the necessity for extending the present workings will require the space now covered up.

Anglo-Canadian mine. Of the three Black Lake mines, the output from the Anglo-Canadian for the six months ending Nov. 15th, was, according to Mr. Hopper, about 210 tons, the average number of hands employed being 30 to 35. The principal pit at this mine has now been sunk to a considerable depth, and Mr. Hopper reports veins of asbestus from the lowest branch of very superior quality ranging from three to seven inches in length. These veins have been uncovered since my visit. The percentage of *firsts* has, according to the manager, increased from 10 to nearly 20 per cent. Openings in the face of the knoll of serpentine to the west of the principal pit are now being worked, and the indications here are very good. The output of the Frechette or D'Auville mine which lies contiguous to the Scottish Canadian, in the face of the hill, is given by Mr. Hopper for the season ending Dec. 1st, as about 300 tons.

Frechette or D'Auville mine.

The Anglo-Canadian mine has also a good outfit of improved machinery, air compressor, drills and hoisting gear, the latter being a necessity owing to the present depth of the quarry. The necessity of some machine which will clear the fibre or separate it from the rock cheaply is one which will doubtless be remedied very shortly. Large masses of granulite also occur near or to the south of these openings. In view of the considerable expense of proving areas where the surface veins are numerous but small, it has seemed to me that a few good test holes with a diamond drill would be advisable. The holes could be quickly and easily sunk, and if veins of asbestus were encountered, the core or borings would shew the character of the fibre and to a certain extent the size of the veins.

The elevation of the Anglo-Canadian mine was, by aneroid, found to be 200 feet above Black Lake station which, in turn, was about 100 feet below Thetford mines station. The workings of these mines would therefore be about on the same level as those of Thetford east of the railway. The D'Anville and Scottish-Canadian mines have an elevation of 350 feet above the station, or 150 feet above the Anglo-Canadian, while the upper works of the latter on the face of the ridge are thirty feet lower.

Elevations of Black Lake mines.

In Thetford, in the areas north of the Quebec Central Railway, are several outcrops of serpentine. These have only lately been examined for asbestus. Among them may be mentioned lots 16, 17 and 18, range IV, from which veins of good size are reported by Dr. Reid, since my visit. In this belt chromic iron also occurs. Mounds of serpentine are also seen in lot 13, range V, and in range XI, Broughton, from some of which asbestus has been reported, but not in quantity sufficient as yet to be of economic value. These areas might easily be tested with the diamond drill.

Serpentine areas of Thetford.

The Broughton Mine, on lot 14, range VII, Broughton, has been worked to some extent during the past two years. I visited it in September 1887, and found it to be somewhat different from the other areas at Thetford and Coleraine. The vein is at the contact of the serpentine, with blackish slates, which in places have a greyish or purple shade, and contain bands of hard bluish-grey quartzite of the Cambrian series thickly veined with quartz. The vein is overlaid in places with soapstone of good quality, from ten to fourteen inches thick, with which the asbestus seems to be intimately associated. The asbestus, of which only one vein could be detected, was eight to ten inches thick in places near the surface, but decreases at the bottom of the workings, which are some 62 feet down, to two or three inches, and becomes irregular, at times splitting into many fine strings disseminated through the serpentine, at others presenting a continuous fibre. Three shafts had been sunk to a depth of 61, 62 and 75 feet, which followed generally the slope of the bed or vein at an angle of about 75°, the rock dipping to S. 40° E. to true meridian; soapstone forms the hanging wall of the vein. The mass of the serpentine which lies to the west was carefully examined at several points, but only in one place, about 150 feet in rear of the openings, were small strings of asbestus of one-fourth to a half an inch seen. Much of the fibre in the north slope appeared to be stiff and harsh and not of good quality, while other portions were beautifully silky. The serpentine of this place resembles in character that near St. Sylvester and along the Chaudière.

Broughton mine.

Probable cause of difference in quality of fibre.

The cause of the great difference in quality of the fibre from different points, more especially comparing Black Lake with Thetford, has long been a source of enquiry among the mine owners and managers. By some it is supposed to be due to the level of the different workings, the works of the Scottish-Canadian Company at Black Lake being about 250 feet above those at Thetford, yet this can scarcely be taken as conclusive, since at the Reid mine, now Wertheim's, 300 feet or so higher, much excellent fibre is found; as also in the works of the Scottish-Canadian Company itself, and the D'Auville mine adjoining, where very fine silky fibre is seen. The fibre at the surface, especially where fire has passed, is always harsher than that from lower depths, owing to the loss of a certain percentage of the contained water; and it has been suggested that a more likely reason for the difference in quality may be the dehydration of the asbestus by the action of the intruded diorite or granulite, which at certain points in the Black Lake district occupy a considerable area. If the soft, silky fibre be placed on the fire, it speedily changes its character and becomes harsh and brittle. The serpentine, near the contact with the granite veins or masses, is often very considerably shattered, as though the presence of the granite had exercised a marked influence.

At Thetford the granitic rock in the mines is limited to small and thin dyke-like veins, which have not produced any deleterious effect upon the asbestus. It must, however, be said that the stiff fibred mineral is not in all cases confined to the vicinity of the visible granites, and other causes may in such cases have produced a similar effect.

Map of asbestus areas.

The map of the asbestus region, accompanying this Report, has been compiled principally from our own surveys, using the line of the Quebec Central Railway, which has been kindly furnished us by the Department of Public Works, Quebec, for a base line. All the mines at present in operation in the districts of Thetford, Coleraine and Wolfestown are indicated on it; but in the attempt to place the lines from the Crown Land plans, so many discrepancies were found in the several surveys available, that the designation of these on a plan certified by the office was found impracticable. A thorough re-survey of these areas is of the greatest importance, since lands which now have a comparatively small value may in a very short time be valued at very large sums. In regard to the areas of Belmina, Wolfestown and Danville no late returns are to hand. At Belmina nothing has been done during the past year, the force there employed being transferred under Mr. Carter to the new Bell Company's property, near Black Lake. Exploratory work has been going on during the past year along the great ridge north of Breeches Lake, but

nothing definite as to results has been received, although such information has been promised. The Danville mine has been working with a reduced force, though at last advices from the Manager the output was increasing and the prospects more favourable. During the past season 207 tons were taken out. Danville mine.

Soapstone.—Many deposits of this mineral occur in Broughton, but the quality is in most cases not sufficiently fine to satisfy the market, the shade being dark and the rock too opaque. Considerable quantities have been shipped from the Broughton Mine, where from the lower asbestus workings a very good quality of the soapstone is obtained The quarry at Belmina, formerly Carter's, now Fenwick and Slater's has also been shipping to various points.

Mineral Paints.—The only locality in this section at which mineral paint was observed is that described in the Catalogue of Economic Minerals, Colonial and Indian Exhibition, London, 1886, at Ste. Anne de Montmorenci, where deposits of brownish and brownish-black iron-ochre of considerable extent occur.

Limestones are found at several points, but are not now burned to any extent, and the facility with which the Dudswell lime can be distributed has caused the abandonment of some kilns. Among other places in Broughton where the rock occurs and has been burnt, may be mentioned, top of hill half a mile east of West Broughton church, near the road. Limestone also occurs on lots 3 and 4, range IV, Thetford, on land occupied by Joseph Ouellette, who has burned it. Near St. Victor de Tring, on the road to St. Francis, a bed of limestone conglomerate has also been used for burning lime. Outcrops of grey limestone are also found along the back roads in rear and to the north-east of Beauce Junction, where several kilns have been burned. The rock is a hard, greyish, sub-crystalline limestone, and occurs with hard quartzites and black slates. Further to the north in Mailloux, lots 30-32, range N.W., along the road, there are several exposures of limestone similar to the last, and with the same association of black slates and quartzites. Localities of limestone.

The deposit on the Chaudière, between the Famine River and the village of St. George, has already been referred to under the head of Devonian. These limestones have been burned for many years for local consumption, and were at one time the chief source of supply for the upper Chaudière district. St. George.

Marble.—A considerable outcrop of deep red marble, veined with white calcite, occurs a short distance east of the Colway (formerly Guillaume) River, associated with red slates and sandstones, which resemble the Sillery of Quebec in lithological character, and may represent an overlying area of these rocks in a synclinal basin such as Colway River.

occurs further east beyond St. Francis village. The bed is from ten to forty feet thick, and is exposed at intervals for half a mile on the strike. The rock takes a good polish, and has a handsome appearance. It is not far from the dioritic rocks which show in the bed of the Colway, and which may have been the cause of the alteration.

Building Stones.—The greenish, grey sandstones of the Sillery formation, both above Quebec and at Point Lévis, produce a very durable stone which has been extensively used both in Quebec and Lévis. The rock splits readily, and blocks of almost any required size can be obtained. Hard and more quartzose beds of the same formation occur at various points, and have already been described. The white granulite rock of Black Lake and Thetford should yield a very handsome and durable stone, but no attempt has yet been made to quarry it.

APPENDIX.

SYSTEMATIC LIST OF FOSSILS, WITH LOCALITIES AS REFERRED TO IN THIS REPORT, EXCLUSIVE OF THOSE SPECIES OBTAINED IN THE LIMESTONE CONGLOMERATE BANDS.†

By Henry M. Ami, M.A., F.G.S., Assistant Palæontologist.

Localities (column numbers):

1. I.C.R. cutting [illegible] Levis, Que., p. [illegible].
2. [illegible] from Levis to St. Joseph, Que., Diplograptus Zone, p. 52K.
3. 150 yards West of last locality, Didymograptus Zone, pp. 52K and 53K.
4. Cliff facing the foundry, Levis, p. 53K.
5. Outcrop at City Hall, Levis, Que., p. [illegible].
6. [illegible] near City Hall, Levis, Que., p. 54K.
7. Mouth of brook 1½ miles N.E. of [illegible] [illegible] p. [illegible].
8. One half mile West of last locality, p. [illegible].
9. [illegible] West of Hadlow [illegible] p. [illegible].
10. [illegible] of Orleans, South-West End, p. [illegible]K.
11. [illegible] Que., 2½m. below St. Anselme, p. [illegible].
12. [illegible] Lawrence R., Que., p. [illegible].
13. St. Anselme, Que., Weston, 18[illegible], p. 63K.
14. St. Bernard, Que., Chaudière R., p. [illegible].
15. St. Michel de Bellechasse, Que., p. [illegible].
16. St. Pascal, [illegible] I.C.R. crossing, p. [illegible].
17. Notre Dame du Portage, Que., p. 68K.
18. [illegible] St. Nicholas, Que., pp. [illegible].
19. [illegible] Nicholas, Que., p. [illegible].
20. Ste. Croix, Que., N. of wharf, p. 17K.
21. Bécancour River, Que., p. 17K.
22. Pointe-aux-Trembles, Que., p. 18K.
23. Lorette, Que., p. [illegible] and 29K.
24. Charlesbourg, Que., fifty yards N. of Ch., p. 2[illegible]K, and 1 mile West of village.
25. Charlesb'g, Que., Templeman's Quarry, p. [illegible]K.
26. [illegible] Que., Paquet's Quarries, [illegible] pp. 21K and [illegible].
27. Montmorency River, above the bridge, left bank, pp. 22K and [illegible].
28. Montmorency R., Que., Ravine below the Falls, p. 23K.
29. Montmorency R., Que., mouth of river [illegible] p. [illegible]K.
30. Montmorency R., Que., [illegible] slope & Lower point, East side of gorge.
31. Below Victoria Hotel, Point Levis, Que., near T[illegible] gate, p. 50K.
32. Below Victoria Hotel, South Que. [illegible] in black and green shales, p. 5[illegible]K.
33. Quebec City, between Grande Allée and New Drill Shed, p. [illegible].
34. Quebec City, between St. John Market and St. Patrick st. [illegible] p. [illegible], 79, and 8[illegible]K.
35. Côte d'Abraham, Quebec City, p. 80K.
36. Chaudière R. R. Bridge, Que., p. 5[illegible]K.

GENERA AND SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Protospongia fenestrata, Salter																																				
[illegible] sp.																																				
[illegible], [illegible]																																				
" " var. [illegible]																																				
? " [illegible] ?																																				
Leptograptus flaccidus, Hall																																				
Nemagraptus capillaris, Emmons																																				
" sp.																																				
Didymograptus [illegible], Hall																																				
" [illegible], Hall																																				
" [illegible], Hall																																				
" [illegible], Lapworth																																				
" [illegible], Hall																																				
" sp.																																				
Tetragraptus [illegible], Nicholson																																				
" bigsbyi, Hall																																				
" [illegible], Hall																																				
" fruticosus, Hall																																				
" Headi, Hall																																				
" [illegible], Lapworth																																				
" quadribrachiatus, Hall																																				
" serra, Brongniart																																				

Dichograptus																															*					
" octobrachiatus, Hall	*				*					?																										
? " Richardsoni, Hall	*				*					*																										
" ramulus, Hall															?																?					
Loganograptus Logani, Hall										*																										
Clonograptus sp.		*											*																							
" flexilis, Hall	*																																			
" rigidus, Hall										*																										
Goniograptus Thureaui, McCoy	*																																			
Dicellograptus Moffatensis, Carruthers																																				
var. divaricatus, Hall											*	*																								
" sextans, Hall											*	*																						*		
" [illegible]											*	*							*																	
? sp.																																	*			
Dicranograptus cf. D. Nicholsoni, Hopk.												*																								
" sp. nov.											*																									
" ramosus, Hall																			*																	
Climacograptus bicornis, Hall											?								*															*		
" var.																																	*			
" var. caudatus, Lapworth																																		*		
" cf. contortus, Lapworth																																	*			
" perexcavatus, Lapworth																																	*	*		
" scalaris, Hisinger																																				
" " var. normalis, Lap																																		*		
" sp.																															*					
" sp.																*																				
" sp.																								*				*	*	*						
Diplograptus angustifolius? Hall																																	?			
" dentatus, Brongniart				*																																
" foliaceus, Murchison																																	?	*		
" cf. folium? Hisinger																															*					
" Hudsonicus, Nicholson																					*															
" latior, N. Sp																		*																		
" mucronatus, Hall											*																							*		
" rugosus, Emmons																																				
" tricornis, Carruthers																															*					
" Whitfieldi, Hall																																		*		
" sp																*																				
" sp											*																				*		*			
" sp																														*						
Orthograptus quadrimucronatus, Hall																		*						*					*							
Phyllograptus angustifolius, Hall						*		*						*																						
" Anna, Hall					*									*																						
" typus, Hall	*	*				*			*																							*				
Glossograptus ciliatus, Emmons																															*					
" sp. indt																															*					
Retiograptus Eucharis, Hall																												*								
Trigonograptus ensiformis, Hall																															*					
Ptilograptus plumosus, Hall										*																										
Dictyograptus, N. Sp (D. delicatulum, Dn. preoccupied)		*		*																																
" irregularis, Hall				*																																
" cf. D. Homfrayi			*																																	
" N. Sp				*																																
Dendrograptus sp.			*												*																					
Dawsonia acuminata, Nicholson										*																										
" campanulata, Nicholson																																	*			
" sp. indt										*					*																	*				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

GENERA AND SPECIES.	1. I.C.R. cutting, 100 paces below the Lower Levis ferry, Levis, Que., p. 52K.	2. Road from Levis to St. Joseph, Que. Didymograptus Zone, p. 52K.	3. 150 yards West of last locality, Didym. Zone, pp. 52K and 53K.	4. Cliff facing the foundry, Levis, p. 53K.	5. Outcrop at City Hall, Levis, Que., 53K.	6. Shales associated with conglomerates near City Hall, Levis, Que., p. 54K.	7. Mouth of brook 1½ miles N.E. of Harlaka Junction, I.C.R., p. 55K.	8. One half mile West of last locality, p. 55K.	9. Snow-shed, cutting West of Harlaka Junction, p. 55K.	10. Island of Orleans, South-West End, p. 59K.	11. Etchemin River, Que., 2½ m. below St. Anselme, p. 60K.	12. Crane Island, St. Lawrence R., Que., p. 61K.	13. St. Anselme, Que., Weston, 1877, p. 61K.	14. St. Bernard, Que., Chaudière R., p. 61K.	15. St. Michel de Bellechasse, Que., p. 66K.	16. St. Paschal, Between de l'Eglise, I.C.R. crossing, p. 68K.	17. Notre Dame du portage, Que., p. 68K.	18. Two miles above St. Nicholas, Que., pp. 14K and 17K.	19. Five and a half miles above St. Nicholas, Que., p. 17K.	20. Ste Croix, Que., N. of wharf, p. 17K.	21. Bécancour River, Que., p. 17K.	22. Pointe aux Trembles, Que., p. 18K.	23. Loretto, Que., pp. 19K and 24K.	24. Charlesbourg, Que., fifty yards N. of Ch., p. 20K, and 1 mile West of village.	25. Charlesbourg, Q., Temperman's Quarry, p. 21K.	26. Beauport, Que., Parent's Quarries, Mr. St. Cyr, 1883, p. 21K and 22K.	27. Montmorency River, above the bridge, left bank, pp. 22K and 23K.	28. Montmorency R., Que., Ravine below the falls, p. 23K.	29. Montmorency R., Que., mouth of river, Lower point, p. 24K.	30. Montmorency R., Que., between steps & Lower point, East side of gorge.	31. Below Victoria Hotel, Point Levis, Que., near Toll-gate, p. 50K.	32. Below Victoria Hotel, South Que., Que., in black and green shales, p. 50K.	33. Quebec City, between Grande Allée and New Drill Shed, p. 77K.	34. Quebec City, between St. John Market and St. Patrick St., pp. 78, 79 and 80K.	35. Côte d'Abraham, Quebec City, p. 80K.	36. Chaudière R. R. R. Bridge, Que., p. 57K.
Corynoides calycularis, Nicholson																			?																	
Glyptocystites or Glyptocrinus																						*						*								
Glyptocrinus decadactylus, Hall																																				
Heterocrinus sp. var. Canadensis, Billings																						*														
Serpulites dissolutus, Billings																												*								
Ptilodictya falciformis, Nicholson																									*											
Pachydictya acuta, Hall																							*		*		*									
Prasopora lycoperdon, Vanuxem																							*		*	*	*									
" " var. Selwyni, N. Var.																																			*	
Diplotrypa Quebecensis, N. Sp.																							*												*	
Batostoma Ottawaense, Foord																							*													
Monotrypa incerta, N. Sp.																																			*	
Amplexopora discoidea, James																										*										
Lingula curta, Hall																											*	*								
" Irene, Billings	*	*		*																																
" obtusa, Hall																										*										
" Philomela, Billings																							*													
" Quebecensis, Billings		*	?	*	*	*			*																											
" riciniformis, Hall																									*											
" sp.			*																																	
" N. Sp. ?																																		*		
" N. Sp.																																		*		
" N. Sp.				*																																
Obolella pretiosa, Billings							?						*		*																					*
" sp.							*																													*
" sp.																																		*		
Elkania desiderata, Billings															*																					
Linnarssonia sp.			*																									*	*							
Leptobolus insignis, Hall																																				
" (?) sp.																			*																	
" N. Sp. (?)				*																																
Acrothele sp.																																		*		
" N. Sp.																																		*		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Schizocrania or Discina, sp.																										*											
? Siphonotreta micula, McCoy		*																																			
Acrotreta sp											*					*																					
Discina Pelopea, Billings																							*													
" sp.																				*																
Paterula Sp. Nov																																		*		
Crania sp																					*				*											
Orthis emacerata, Hall																				*																
" pectinella, Conrad																											?									
" testudinaria, Dalman																		*		*		*	*		*		*	*							?	
" sp. nov. (?)																							*													
" sp																															*					
" sp				*																																
" sp																	*																			
" sp.																																		*		
Skenidium ? sp.																							*													
Strophomena alternata, Conrad																				*		*	*		*		*									
" deltoidea, Conrad																						*				*										
" sp.																	*																			
Leptaena sericea, Sowerby																		*		*		*			*	*	?	*						?	?	
" N. Sp																																		*		
Zygospira Headi, Billings																		*		*	*															
" modesta, Say																											?									
" or N. G																							*	*	*		?	*								
Anazyga recurvirostra, Hall																				*							*									
Stricklandinia ? sp																																		*		
Camerella hemiplicata, Hall																							*			*										
" n. sp. (?)																							*													
Pterinea Trentonensis, Hall																							*													
Ambonychia radiata, Hall																		*		*	*															
Modiolopsis sp																							*													
" sp.																		*																		
Vanuxemia sp.																											*									
Ctenodonta dubia, Billings																							*													
Lyrodesma pulchellum, Emmons																										*										
" sp.																				*																
Orthodesma parallelum, Hall																		*		*																
Murchisonia gracilis, Hall																				*							*									
" perangulata, Hall																											*									
Bellerophon bilobatus, Sowerby																				*			*	*			*									
Bucania punctifrons, Emmons																							*				*									
Cyrtolites sp.																																		*		
Conularia Trentonensis, Hall																							*			*	*									
Theca N. Sp																							*													
Lituites undatus, Emmons																							*													
Endoceras proteiforme, Hall																							*		*	*			*							
Orthoceras anellum, H. or N. Sp.																										*	?									
Tarrilepas sp											*																										
Leperditia cylindrica, Hall																								*												
Primitia Canadensis, J. var. nana, Jones																							*													
" N. Sp																												*						*		
Beyrichia N. Sp																							*													
" sp																	*																			
Shumardia granulosa, Billings			*	*																																
Trinucleus concentricus, Eaton																							*				*									
" N. Sp. (large form)																		*		*																
" sp.																																		*		
Ampyx sp.																																		*		

GENERA AND SPECIES.	1 I.C.R. cutting, 19 0 paces below the Lower Levis ferry, Levis, Que., p. 52K.	2 Road from Levis to St. Joseph, Que., Didymograptus Zone, p. 52K.	3 150 yards West of last locality, Didymograptus Zone, pp. 52K and 53K.	4 Cliff facing the foundry, Levis, p. 53K.	5 Outcrop at City Hall, Levis, Que., p. 53K.	6 Shales associated with conglomerates near City Hall, Levis, Que., p. 54K.	7 Mouth of brook 1½ miles N. E. of Harlaka Junction, I.C.R., p. 55K.	8 One half mile West of last locality, p. 55K.	9 Snow-shed cutting West of Harlaka Junction, p. 55K.	10 Island of Orleans, South-West End, p. 59K.	11 Etchemin River, Que., 2½ m. below St. Anselme, p. 60K.	12 Crane Island, St. Lawrence R., Que., p. 61K.	13 St. Anselme, Que., Weston, 1877, p. 61K.	14 St. Bernard, Que., Chaudière R., p. 66K.	15 St. Michel de Bellechasse, Que., p. 66K.	16 St. Paschal, Ruisseau de l'Eglise, I.C.R. crossing, p. 68K.	17 Notre Dame du Portage, Que., p. 68K.	18 Two miles above St. Nicholas, Que., pp. 15K and 16K.	19 Five and a half miles above St. Nicholas, Que., p. 16K.	20 Ste. Croix, Que., N. of wharf, p. 17K.	21 Bécancour River, Que., p. 17K.	22 Point-aux-Trembles, Que., p. 17K.	23 Lorette, Que., pp. 19K and 20K.	24 Charlesbourg, Que., fifty yards N. of Ch., p. 20K, and 1 mile West of village	25 Charlesb'g, Que., Templeman's Quarry, p. 21K.	26 Beauport, Que., Parent's Quarries, Mr. St. Cyr, 1888, p. 21K and 22K.	27 Montmorency River, above the bridge, left bank, pp. 22K and 23K.	28 Montmorency R., Que., Ravine below the Falls, p. 23K.	29 Montmorency R., Que., mouth of river, Lower point, p. 24K.	30 Montmorency R., Que., between steps & Lower point, East side of gorge, p.	31 Below Victoria Hotel, Point Levis, Que., near Toll-gate, p. 50K.	32 Below Victoria Hotel, Point Levis, Que., in black and green shales, p. 50K.	33 Quebec City, between Grande Allée and New Drill Shed, p. 71K.	34 Quebec City, between St. John Market and St. Patrick St., pp. 78, 79, and 80K.	35 Côte d'Abraham, Quebec City, p. 80K.	36 Chaudière R., R'y Bridge, Que., p. 57K.
Triarthrus Becki, Green																								*				?	*	*						
Hydrocephalus sp.																																		†		
Bathyurus sp.																																		*		
Calymene senaria, Conrad																				*		*	*		*	*		*								
Asaphus platycephalus, Stokes																						*	*			*	*									
" Canadensis, Chapman																							*													
" sp.																																		*		
Illænus Milleri, Billings																							*				*									
" Bouchardi, Barrande																																		?		
" sp.																												*								
Æglina rediviva, Barrande																																		*		
Dalmanites callicephalus, Green																						*	*													
" sp.																				?																
Cheirurus pleurexanthemus, Green																						*	*			*	*									
" sp.																																		*		
Encrinurus vigilans, Hall																							*				?									
" sp.																				?																
Cyphaspis sp.																																		*		
Harpes sp.																											*									

† In the limestone ridges west of the Cemetery, see p. 81K, the rock consists largely of solid limestone which contains fossils of Calciferous age—scattered pebbles and boulders, sometimes of large size are found in the mass—and these contain fossils of Cambrian (Potsdam) age.—R. W. E.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON

EXPLORATIONS AND SURVEYS

IN PORTIONS OF

NORTHERN NEW BRUNSWICK,

AND ADJACENT AREAS IN

QUEBEC, AND IN MAINE, U.S.

BY

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AND

WM. McINNES, B.A., F.G.S.A.

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ALFRED R. C. SELWYN, C.M.G., F.R.S., LL.D., &c.,

Director of the Geological and Natural History Survey of Canada.

SIR,—The following report is based upon observations made by the authors, with the assistance of J. W. Bailey and W. H. T. Reed, during portions of the summers of 1886 and 1887, in Northern New Brunswick and adjacent areas of Maine and Quebec.

It also embraces a summary of the facts, ascertained from a general review of the entire Silurian system in this section of the Dominion, including its extent, its order of succession, and its relations to the formations which lie below and above it.

The map intended to accompany the present report, and representing the geology of portions of Madawaska county, New Brunswick and Temiscouata county, Quebec, is in the hands of the engraver, and will be issued when completed. It is Sheet No. 17 N.E. of the series of maps on a scale of four miles to an inch, and, as regards New Brunswick, is the last but one of the series.

A tabulated list of the fossils of the region is given in the form of an Appendix by H. M. Ami, by whom the lists of fossils in the body of the report have also been prepared.

The thanks of the authors are due to the Manager of the New Brunswick Railway for the continuation of courtesies extended since the commencement of the survey.

Respectfully yours,

L. W. BAILEY.
WM. McINNES.

FREDERICTON, N.B., February, 1889.

REPORT

OF

EXPLORATIONS AND SURVEYS

IN PORTIONS OF

NORTHERN NEW BRUNSWICK,

AND ADJACENT AREAS IN

QUEBEC, AND IN MAINE, U.S.

The areas to be described in the present report lie to the west and north-west of that described in last year's report, and correspond to portions of two sheets of the New Brunswick and Quebec series of geological maps. In the one of these sheets (No. 17 N.E.) the district represented is limited to that small portion of New Brunswick which is included between St. John River and the Quebec boundary, while that of the second (No. 18 S.E.) lies immediately north of and is continuous with the latter, embracing, in addition to a very small part of New Brunswick, a considerable portion of the county of Temiscouata, in the province of Quebec. Region described.

Owing, however, to the very peculiar position and relations of the geographical and political boundaries in this region, which gives to that portion of New Brunswick embraced by it, the form of a long, narrow wedge, enclosed between Quebec on the one side and the state of Maine on the other, and having for a considerable distance a width of fifteen or twenty miles, a study of the geological features has necessarily included an examination of the adjacent areas. In the case of the state of Maine, this has been found especially serviceable, as in connection with the numerous streams and lakes which, in the county of Aroostook, are tributary to the St. John, ample and unusual facilities are afforded for the study of the rock formations there met with, and which in their north-eastward extension enter and traverse New Brunswick. On the other hand, the character and relations of the Silurian rocks about the northern boundary of New Brunswick cannot well be understood apart from their representation in the adja- Adjacent areas in Quebec and Maine.

Comparison with other regions.

cent portions of Quebec, and more particularly as revealed in the sections made respectively by the Metapedia River and Lake Temiscouata, with the intervening streams. For these reasons, and with a view to bringing together, for comparison, all the available data relating to the succession and relations of the Silurian system in this section of the continent, the observations to be given have been extended considerably beyond the limits of the two map sheets to which reference has been made. For similar reasons, little account is taken in the following descriptions of either the interprovincial or international boundaries by which the region is traversed. The geology of only those portions, however, which are included within the territorial limits of Canada is represented in the accompanying maps.

Topographical features.

The topographical features of the region under consideration are deserving of brief notice, not only as being in themselves somewhat remarkable, but also as bearing on the adaptability of the country for settlement, and as helping to elucidate its geological structure.

St. John River and its tributaries.

Most noticeable, probably, among these features is that connected with the position and course of the St. John River and its tributaries. In no portion of its extensive drainage area does this river receive so many and such important affluents as here. Flowing north-easterly from its source in Baker Lake, situated near the western frontier of Maine, and at a distance, measured along the stream, of 460 miles from its mouth, it first reaches New Brunswick at the mouth of the St. Francis, and thence forms the international boundary to a point a few miles above the Grand Falls. Above the St. Francis, which also forms a part of the same boundary, and is a considerable stream, draining some important lakes, the main river has already received upon its northern side the waters of the Big Black and the Little Black rivers, both sufficiently large to be navigable by canoes, while from the southern side it is similarly joined by the still more considerable stream of the Alleguash. This latter takes its rise in a very remarkable system of lakes, of which the most southerly (Lake Chamberlain) approaches so nearly the head waters of the Penobscot, and is so nearly on a level with it, that by the erection of dams, much of the water, at one time tributary to the St. John, has been diverted, for lumbering purposes, into the first-named stream. Below the mouth of the St. Francis, the principal tributaries of the St. John upon the northern side are the Madawaska and the Green River, to which may be added the Iroquois, the Quisibis, the Siegas and the Grand rivers, of less importance than the streams first named, but still large enough to be navigable by canoes. Even the Aroostook may properly be included here, for it drains the same Silurian basin, and has its origin in lakes but little removed from those in which Fish River, the Alleguash and the Penob-

St. Francis River.

Big Black and Little Black Rivers.

Alleguash River.

Tributaries below the St. Francis.

Aroostook River.

scot have their origin. This close approximation of considerable streams, flowing in diverse directions and often for great distances, is a very peculiar feature of the region, and, taken in connection with the comparatively unsettled character of the country which they drain, the beauty of the scenery, and the abundance of fish and game, has made the whole region famous among tourists and sportsmen.

Fish and game.

The lakes of the region, already incidentally referred to, are as remarkable as the number and variety of its streams. In Aroostook county, Maine, they are exceedingly numerous, and of all shapes and sizes, but often so situated as to indicate that they are but isolated portions of what were once continuous and much more considerable basins. Of these, the most important, in relation to the present report, are those which form the sources of Fish River, and which, in the form of a chain, embracing Long Lake, Second or Mud Lake, Cross Lake, Square or Sedgewick Lake, Eagle Lake and Nadeau or Upper Lake, occupy a trough roughly parallel with the St. John. This trough in its eastern extremity (in Long Lake) is not over seven miles distant from the St. John. In Quebec, the lakes are less numerous, but among them is Lake Temiscouata, the most considerable of all as regards both extent and depth. This remarkable and very beautiful sheet of water has a total length of twenty-four miles, with a breadth varying from one to two miles, its general form, as accurately surveyed by the Geological Survey, being that of the letter L, with the longer or southern arm somewhat irregularly sigmoid. This longer limb, taken as a whole, has a course almost exactly N.W. and S.E., corresponding on the one side with that of the Madawaska and a considerable portion of the St. John, while on the other, an extension of the same line will be found to coincide with that occupied, at a distance of about forty-six miles, by the deep gorge of the Saguenay. The depth of Lake Temiscouata is itself somewhat remarkable, though less so than has been sometimes represented, accurate and systematic soundings made over its different portions showing that it varies but little from 220 feet.*

Lakes of the region.

Fish River Lakes.

Lake Temiscouata.

As would naturally be expected, the hydrographic features of the district just described are intimately connected with, and in part dependant upon, its orographic features. There are, however, in these relations, many points which are somewhat peculiar, and cannot be readily accounted for, except by reference to the former existence here of conditions and the occurrence of operations somewhat different from those which now prevail.

Peculiar features.

*In a note contributed by one of the authors to Science (Vol. VIII., No. 196) it is stated that the depth of the lake is, in some parts, over 500 feet. The statement was the result of a return submitted by a person in our employ who was engaged to make the soundings, who had already made several in our company, and in whom we had every reason to place confidence. Subsequent examinations, however, revealed, to our great surprise and disappointment, that the work thus done, if done at all, was entirely untrustworthy.

Canoe-shaped ridges.

Over the larger part of the area to which this report relates, the country is hilly, though there are few elevations of any considerable altitude. In general, the eminences are in long, canoe-shaped ridges, with easily-flowing outlines, but these are sometimes replaced by serrated crests, or, in the case of transverse river valleys, by bold escarpments. In the southern part of the tract, Green River Mountain, not far from the mouth of Green River, rises somewhat abruptly from a comparatively low country, and constitutes a very prominent object in the landscape. There are also other noticeable hills along the middle and upper courses of the same stream, but it is not until we approach Edmundston that the country begins to acquire a really rugged aspect. It is here that the St. John is joined by its main tributary, the Madawaska, and along both streams, the valleys which they occupy are bordered by a continuous succession of high rolling hills. In the case of the St. John, however, these, except within a few miles of Edmundston, run parallel to the stream, or cross it at very small angles (then usually determining the existence of rapids), while in the case of the Madawaska, its course is almost directly transverse to that of the hill ranges which border it, and which accordingly abut against it in bold and often craggy heights. Again, in the case of the St. John, the larger part of the valley is occupied by the stream itself and its immediate flood grounds, only rarely expanding to include any considerable extent of flat land; but on the Madawaska, the stream, in its present state, occupies but a very small proportion of the entire valley, being rarely more than 200 feet wide, while the valley, which is nearly everywhere flat, is seldom less than a mile in width. The great transverse trough which is thus indicated is, at its northern end, continuous with that of Lake Temiscouata, but here the whole valley is again occupied by the hills upon either side rising abruptly from the lake, as they also sink with almost equal abruptness to great depths below its surface. In the case of Mt. Wissick or the Big Mountain, nearly opposite old Fort Ingalls, they rise almost precipitously to a height of 550 feet, while at a distance of not over 100 feet from the base of the bluff, the depth of water is over 200 feet.

Green River Mountain.

Madawaska and St. John valleys.

Glacial origin of valleys.

From the features above described, as well as from others, such as the direction of glacial striæ, and the nature of the material occupying different portions of the Temiscouata-Madawaska valley, it would seem as though the latter were a great trough of sub-ærial glacial erosion, having throughout, at one time, a depth at least equal to that of the existing lake, but which, with the retreat and melting of the ice eventually became to a large extent filled up.

The nearly uniform and flat contour of the lake bottom, its very gradual or progressive shallowing at the southern extremity, and the

extensive deposits of clay which occupy portions of the valley of the Madawaska, are all in accordance with the view here advocated. It may be added, as bearing further upon the same theory, that while Mt. Wissick, abutting, as stated, directly upon the lake, with a height of over 500 feet, is but a part of a ridge which, in an easterly direction, is traceable with equal prominence for a distance of ten miles or more, on the opposite or western side of the lake, though only a mile distant, no such corresponding ridge is to be met with, nor any trace of the rocks of the mountain, except such as form its basal beds. Finally, it may be mentioned that large boulders, filled with fossil corals similar to those of the limestones of Mt. Wissick, have been observed far down the valley of the St. John, though no beds of similar character are known to occur anywhere in the interval.

Mt. Wissick.

Erratics.

The evidences of glaciation about the shores of the lake are abundant and varied, the surfaces of the slaty rocks which dip into the latter being everywhere smoothed, rounded, furrowed or striated. Some of the effects are doubtless attributable to the mere pressure of the lake ice, but others are far beyond its reach, and must have been produced by an ice-stream or glacier, filling the valley to a much greater depth, and which at the same time ploughed deeply into its bottom. To the action of such an ice-stream or glacier, the origin of the valley is largely to be ascribed. The course of the striæ above the limits of recent ice action varies from S. 45° E. to S. 60° E., the former corresponding with the axis of the lake itself, south of its principal bend. The upper part of the lake, which is very much shallower, corresponds in direction to that of the hills and rock formations which border it; but here another very peculiar feature presents itself in the fact that the movement of the ice, as indicated by the position of the travelled boulders, was to the north and north-east, rather than to the south. Thus above Mt. Wissick, which occupies the angle between the two main limbs of the lake basin, the shores of the latter are strewed with blocks of all sizes, some of them six or eight feet in diameter, which are simply detached masses from the fossiliferous rocks of the mountain, and which must have been transported several miles from their parent bed. This is in accordance with similar facts noticed by the authors on Lake Metapedia, and by Mr. R. Chalmers in other parts of the Gaspé Peninsula.

Glaciation.

Of other facts connected with the Post Tertiary history of the Temiscouata region, it is worth noticing that the other lakes of the district do but repeat, though upon a somewhat smaller scale, the features of Temiscouata itself. Thus the chain of the Squatook Lakes upon one side and that of Cabano on the other, both tributary to Lake Temiscouata, and almost exactly parallel to it, like it are situated nearly at

Parallelism of lake basins.

right angles or obliquely to the rock formations and are of exceptional depth. The same north-west and south-east trends are repeated in the valley of Baker Lake and Brook, in that of the St. Francis River, including Boundary and Glazier Lakes, still further west in the course of the Big and Little Black rivers, and eastward of Temiscouata in the tributaries of the Green River and the Restigouche.

Kames.

The last feature which we shall notice in this connection is that of the occurrence of kames or horse-backs over some portions of the region. Of these, one of the most noticeable is to be seen in the vicinity of old Fort Ingalls, and for a short distance constitutes the foundation of the thoroughfare leading to the latter. It is about half a mile in length, and about thirty or forty feet in breadth at the top, having a somewhat sinuous course, but a general trend nearly S. 20° E., or the same as that of the lake on whose shore it terminates. It is composed chiefly of coarse sand and gravel, and traverses a low flat tract which, in part, at least, is occupied by beds of clay. Other kames, but of less marked character, were observed at other points, especially a few miles above the mouth of the St. Francis, on the Maine side of the St. John.

Character of soils.

The soils of the district under discussion are similar in origin, and hence similar in character, to those of the Silurian tracts further south, which have been described in earlier reports. They would seem, however, to be of less depth than the latter, as well as less calcareous, and hence less well adapted for purposes of agriculture. Along the valley of the St. John, there are many good farms, and excellent land for farming purposes is said to exist over large portions of the country drained by the tributaries of the St. John and Restigouche rivers, but to the north of Edmunston and in the county of Temiscouata, the country is so hilly as to interfere materially with tillage operations, while the shortness of the season and the constant liability to destructive frosts, are serious drawbacks to the settler. The valley of the Madawaska, it is true, is an exception to the generally hilly character of the region, but the sandy and clayey nature of the deposits with which it is filled is equally unfavorable to its productiveness, and though farms are numerous, they are in general of inferior character. The whole of the country east of Lake Temiscouata, and much of that west of it, is still in forest, and is the seat of important lumbering operations.

Formations

The geology of the region, to which this report relates, embraces, according to our present knowledge, only strata of Silurian and Ardovician or Cambro-Silurian age. As the principal portion, however, of the area occupied by the latter, which extends to the shore of the St. Lawrence, has been only partially examined, and is still under discussion, it is not proposed to consider it here, except so far as it comes in contact with the Silurian system; the present report is therefore essentially confined to the consideration of the latter.

The first systematic description of the Silurian rocks in this portion of America is that contained in the "Geology of Canada, 1863," where an elaborate section is given of these rocks, as seen at the extremity of the Gaspé Peninsula, together with many details of their distribution in other parts of that peninsula, as well as westward in the valleys of the Metapedia, Patapedia and Metis rivers, about Lake Temiscouata and above the upper tributaries of the river St. John. The section at Gaspé, which is unequalled in its extent and clearness of exposure, was justly regarded as typical, and the name of Gaspé series was applied to that portion of the strata there exhibited, chiefly limestones, which was supposed to represent the Silurian system, as distinguished from an overlying mass of sandstones (Gaspé sandstones), which were regarded as Devonian. Subsequently, a further examination of portions of the Silurian district was made by Mr. Richardson (Report of Progress, 1869), and numerous fossils were collected by him as well as by E. Billings, T. C. Weston and others. Still later, in 1882-83 Messrs. Ells and Low, of the geological corps, made additional observations in the interior of the Gaspé peninsula, and the results are embodied in two reports, accompanied by maps showing the distribution of the formations, with large lists of fossils. In one of these reports, the fossils collected were regarded as indicating that a considerable portion of what had been considered as Silurian was in reality Devonian, but this view was subsequently abandoned. Finally, between the years 1883 and the present time, the authors of this report, while pursuing their investigations in Northern New Brunswick, have not only made numerous sections and careful surveys of the Silurian rocks included in that province, but, by extending their observations into the adjacent state of Maine, have obtained much valuable information regarding the succession of the Silurian rocks. The results of these explorations, so far as they relate to the mere details of distribution and lithological characters, have already been given in several preceding reports, with accompanying maps, but, with the exception of two communications made by one of the authors to the Royal Society of Canada, and published in its Transactions, no attempt has been made to institute comparisons or to draw any general conclusions. In the present report, it is our aim to summarize the information now available, in order to show how far it confirms or modifies the results of earlier observers, and to indicate some of its bearings upon general questions of geological history.

Former reports Geology of Canada, 1863.

Richardson, 1869.

Ells and Low, 1882-83.

Bailey in Trans. R. S. C

Gaspé Peninsula.

Gaspé section.

As a basis of comparison, it will be convenient to give here a summary of the succession, as revealed in the typical section of the Silurian rocks at Cape Gaspé. This, condensed from the Geology of Canada, page 391, is as follows :—

1. Grey limestones, in layers from six to eight inches thick, separated by greenish calcareo-argillaceous shale; the limestones abounding in fossils, including, among others, specimens referable to the following genera ; *Favosites, Zaphrentis, Dictyonema, Fenestella, Strophomena, Orthis, Rhynchonella, Pentamerus, Spirifera, Athyris, Atrypa, Cyrtodonta, Modiolopsis, Avicula, Loxonema, Bellerophon, Platyceras, Conularia, Orthoceras, Dalmanites, Phacops, Bronteus* and *Beyrichia.* 70 feet.

2-3. Calcareo-argillaceous shales of red and green colors, with nodules and layers of limestone, and remains of marine plants. 260 feet.

4. Grey limestones in thin beds, with separating layers of grey calcareous shale, and including about seven feet of limestone and limestone shale, of which the layers have been in part excessively corrugated and in part disrupted into fragments. Fossils less numerous than in 1. 200 feet.

5-6. Grey or greenish calcareous shales or shaly limestones, sometimes arenaceous, with thinner beds of pure limestone. Fossils—Brachiopods and trilobites. 680 feet.

7. Grey nodular shaly limestones, with some greenish calcareo-arenaceous shales. The only fossils are one resembling *Spirophyton caudagalli*, and *Dalmanites pleuroptyx.*

Thickness and age.

The lowest beds of the above section rest upon black shales, which have been supposed by Prof. Lapworth to hold a position inferior to the rocks of Point Lévis, while those of its highest member are succeeded by arenaceous beds, abounding with fossil plants and forming a portion of the Gaspé sandstone series, of Devonian age. The entire thickness of the Silurian sediments, as given above, amounts to about 2000 feet, and their age, collectively, is regarded as about that of the Lower Helderberg formation. The rocks of the inferior Niagara group, though abundantly represented on the island of Anticosti, appear to be wanting here.

Base of Silurian in the Shickshocks.

Of the geology of the interior of the Gaspé peninsula, we do not here propose to speak, as we have no personal knowledge of its features, and can add nothing to the information already given in the Geology of Canada and the later reports of Dr. R. W. Ells and his associates. It is, however, necessary to observe that at several points along the south side of the Shickshock Mountains, notably at the sources of the Chatte and Matane rivers, the base of the Silurian system is represented by massive beds, from 50 to 70 feet thick, of white, quartzose sandstone,

often vitreous in aspect and speckled with small, red, ferruginous spots. They are directly succeeded by fossiliferous limestones, holding species similar to those contained in the upper part of the Anticosti group, and the two are hence regarded as marking an horizon about that of the Niagara formation. Collections of fossils made by Dr. Ells and his associates, on the Scaumenac and Little Cascapedia rivers (Report of Progress, 1882-83-84), have also been thought to indicate a similar horizon. On the other hand, a considerable area of rocks occurring in the basin of the Casupscal River, and thence extending eastward to and beyond the Cascapedia River, and which also formed a portion of the Gaspé limestone series, as originally defined, were found, by the same author, to contain numerous fossils, indicating their probable equivalency with the Oriskany and Hamilton formations of the Devonian system.

Fossils collected by Dr. Ells.

Palæontological evidence relied upon.

Thus the boundary, as indicated between the Silurian and Devonian systems in this region, seems to have been determined upon palæontological grounds rather than upon the lithological and stratigraphical evidence, and the evidence would also seem to afford some confirmation of the view that the Oriskany is not only a transitional formation, but more nearly related to the Silurian than it is to the Devonian system.

The first observations made by us bearing upon the geology of this region were made during the season of 1888, along the course of the Metapedia River, and about the lake of the same name, from which it flows.

Metapedia Lake.

The geology of the eastern side of Metapedia Lake, having been described in the geology of Canada, and represented in the published maps accompanying the report by Dr. Ells, need not be discussed here. Upon the western side, near the head of the lake, the lowest visible Silurian rocks are whitish sandstones, sometimes exhibiting a pinkish tinge or speckled with small red spots. As stated in "Geology of Canada, 1863," p. 414, these rocks are undoubtedly the equivalents of the similar beds on the Matane River, and, if the latter are correctly referred, would represent the upper part of the Anticosti group, or that of the Niagara formation. They may be seen at several points along the margin of the lake, and form the whole of an island near its southern extremity, but in most places they are concealed either by overlying limestones or by drift. The drift contains numerous and often large blocks of the white sandstone, from which the only fossils as yet found have been obtained. In a collection made about two miles above Cedar Hall, the following fossils have been determined by Mr. Ami.

Fossils in loose blocks.

Fossils from Cedar Hall.

ZOOPHYTA.

Crinoidal Columns.

Zaphrentis or *Streptelasma*, sp. indt. Several casts and impressions of a Zaphrentis-like coral, resembling a species described by Prof. Hall in the 2nd volume of Palæontology of New York.

BRACHIOPODA.

Orthis (?) sp.

Pentamerus oblongus, Sowerby. Numerous large casts, which show the position of the internal plates.

GASTEROPODA.

Murchisonia, sp.

Oriostoma, sp. Several casts, which most probably belong to this genus, and resemble closely, depressed specimens of *O globosum.*

TRILOBITA.

Lichas (?) sp. A fragment resembling the tuberculated test of a trilobite allied to *Lichas*, but not large enough to warrant accurate determination.

Fossils from six miles above Cedar Hall.

The limestones, which may be seen to directly overlie the sandstones, and which are themselves quite hard and siliceous, are more abundantly fossiliferous, and from beds of the latter, exposed in the large quarries opened during the construction of the Intercolonial Railway, six miles above Cedar Hall station, the following were collected :—

Cyathophylloid coral.
Body-volution of a large gasteropod, perhaps of a *Pleurotomaria.*
Halysites catenulatus.
Crinoidal fragments.
Strophomena rhomboidalis, Wilckens.
Strophodonta varistriata.
Strophodonta Becki? Hall.
Meristella sp., cf. *M. didyma.*
Atrypa reticularis, L; very abundant.
Platyceras sp. indt.
Oriostoma globosum, Schlotheim.

The above-named fossils tend to confirm the idea that the beds containing them hold a position corresponding nearly, to that of the Niagara formation. It may be added that at the extreme northern end of the lake, as well as on the way to Sayabec, there are boulders, of a very

large size, of a grey conglomerate, holding limestone pebbles in a sandy matrix. These contain large corals and brachiopods of Silurian type. They repose upon rocks of the Quebec group, and can hardly have travelled to any great distance, but the source from which they were derived is not known.

Strata on west shore of Metapedia Lake.

Along the entire western margin of the lake, the strata present low undulations, the dip rarely rising above 8° or 10°, and no higher beds than those above noted are observed, but near the outlet and along the course of the Metapedia River are numerous sections which appear to belong chiefly to the higher members of the formation. They have not been examined in detail, but so far as seen, they appear to be quite similar to the strata described in previous reports as covering such large areas in northern New Brunswick and Maine. They consist, for the most part, of dark grey, bluish-weathering, calcareous slates, which, however, occasionally include beds of fine-grained, calcareous sandstone, or, less frequently, thin beds of limestone. The strong and highly inclined cleavage planes by which they are everywhere intersected, and the influence of the latter upon their weathering, gives rise to steep hills, narrow defiles, and, in places, to a landscape eminently bold and craggy, suggesting the idea of a highly-disturbed region. The inclination of the strata is, however, in reality, usually quite low, and the same beds are undoubtedly several times repeated through the fifty or more miles of distance which the section covers. Compared with the section at Cape Gaspé, these strata would appear to appertain chiefly to Div. 5-6, but the fact that fossils of Devonian type occur in the valley of the Casupscull, as observed by Dr. Ells, may perhaps be regarded as indicating that the entire series is here represented. As a basis of further comparison, we add here the following list of forms collected in the vicinity of Dalhousie, N B., and now in the cabinet of the University of New Brunswick :—

Fossils from Dalhousie, N.B.

Favosites basalticus.
" *Gothlandicus.*
Halysites catenulatus, L
Syringopora.
Diphyphyllum.
Zaphrentis.
Fenestella.
Stenopora.
Orthis testudinaria, Dalman, or an allied species.
" *oblata*, Hall.
Strophomena rhomboidalis, Wilckins.
Strophodonta punctulifera, Conrad.

Strophodonta varistriata, Conrad.
Spirifera cycloptera, Hall.
Atrypa reticularis, *L.*
Cyrtina Dalmani, Hall.
Rhynchonella vellicata, Hall.
Athyris princeps ?
Leptocœlia, allied to *L. hemispherica*.
Megambonia, allied to *M. ovoides*, Hall.
Conocardium.
Pleurotomaria, allied to *P. labrosa*, Hall.
Euomphalus sinuatus (?) Hall.
Dalmanites.

The species above named were determined by Mr. Billings, who regarded them as indicating the horizon of the Port Daniel limestones of the northern side of the Bay Chaleur, and as intermediate in age between the Niagara and Lower Helderberg groups.

Low, flat country.

In conformity with the nearly horizontal attitude exhibited by the rocks along the western shore of Lake Metapedia, the country underlaid by the latter is also, for the most part, flat and relatively low. From the upper half of the lake, a similar, broad, flat and often swampy tract stretches to the westward to and beyond the Metis River. Bordering this tract upon its southern side, and stretching in a direction about west-southwest, a ridge of hills is seen to rise into considerable prominence, forming part of the range of the Notre Dame Mountains. From the abruptness with which these hills begin, and their altitude and boldness of outline, the idea is forcibly suggested that they are portions of an older series, or at least of harder or more highly disturbed strata than those which border them. Several attempts have accordingly been made to ascertain their true nature, but, even in the case of the steeper portions, these have failed so far to reveal any outcrops nor any debris other than that of the ordinary Silurian slates.

Notre Dame Mountains.

Metis and Patapedia Rivers.

The geology of the Metis and Patapedia rivers is given, in considerable detail, in the Geology of Canada, p. 416; we had hoped to have re-examined this section, and to have made more ample collections of the fossils which it yields, but were prevented from so doing from the want of sufficient water in the Metis River. We, however, ascended one of the tributaries of the Metis, the Musquegegish, a stream previously explored, to a point not more than a mile from its source in a lake of the same name. This lake itself is not far removed from the lakes at the heads of the Rimouski and Quatawamkedgwick rivers, and the information which it affords, in connection with that obtained

upon the last-named streams, to be presently described, gives the key to the character of a large tract, about which little was previously known. The rocks of the Musquegegish, as might be inferred from its position, are much like those of the Metis, and are, in places, sparingly fossiliferous.

On tracing the northern border of the Silurian tract to the westward, the white sandstones at the base of the series, which on the Metis are represented only by loose blocks, come again somewhat prominently into view near the eastern extremity of the settlement of St. Gabriel, and about half a mile from where the Rouge stream is crossed by the Taché road. The beds here dip S. 25° W.<20°, and are, as on Lake Metapedia, directly overlaid by beds of dark blue limestone, forming together a series of low bluffs along the road leading around the eastern extremity of Mount Commis. The limestones contain fossils, but they are neither so abundant nor so well preserved as where the same beds come out a few miles to the westward, at the falls of the Big Neigette River. This fall, about 100 feet in height, and the very similar one of the Little Neigette, seventy feet, result from the singular abruptness with which the Silurian rocks terminate along their northern edge, forming an escarpment which constitutes a prominent feature in the landscape, and which is partly continuous with Mount Commis, and extends thence and to the westward for a distance of twenty miles, terminating in the ridge of the Bois Brulé, near St. Blandine. The rocks of the Neigette Falls, which are partly limestones and partly limestone-conglomerates, are chiefly remarkable for the number and the large size of the fossil corals which they contain, the chain-coral (*Halysites catenulatus*) being especially abundant. The limestones are, to some extent, burnt for lime, but are not well suited for the purpose, being quite siliceous and impure. Their dip is S. 80° W.<1°-20°.

Sandstones at St. Gabriel.

Neigette falls.

Silurian escarpment.

On the summit and around the flanks of Bois Brulé Mountain, admirable opportunities are afforded for the study of the strata of which it is composed, and which are here of more than usual interest. On the precipitous northern face of the mountain, the rocks are chiefly hard, grey, calcareous sandstones, the continuation probably of similar beds overlying the limestones at the Neigette Falls. They dip S. 47° E.< 40°, and contain a few large corals, as well as crinoid stems and ribbed shells, but these are mostly poorly preserved. Ledges of similar sandstone also form the summit of the mountain, but on the southern slope, looking towards Ste. Blandine, beds are met with in which the organic forms are both more numerous and more perfect. One bed, consisting of a buff-weathering dolomitic sand-rock, is especially remarkable as containing little besides the remains of large *Pentameri*, the species,

Bois Brulé Mt.

though belonging to the section of which *P. Knighti* is the type, exhibits, nevertheless, specific differences, and is apparently new. In a collection subsequently made, however, by one of the authors, from a light grey impure limestone, several fine and very large individuals of what is undoubtedly the species last-named, were found associated with crinoidal and cystidean fragments, a *Chonetes* (or a form nearly related thereto), a *Merista* (being a young individual, either of *M. subquadrata* or *M. princeps*, Hall), and an imperfectly preserved *Euomphalus*. Mr. Ami suggests these strata may be the equivalents of the Aymestry beds of Great Britain, and perhaps of one of the zones called by the New York geologists Pentamerus limestone. A mile or so to the westward, still other fossiliferous beds appear. One of these is near the foot of the hill on the northern side, in the valley of Bois Brulé River, and is a drab-weathering, argillaceous and shaly limestone, from which the following fossils were obtained by Messrs. Ells and Ami:—

Fossils at Bois Brulé Mtn.

Halysites catenulatus, L.
Strophomena rhomboidalis, Wilckens.
Orthis, cf. *O hybrida*, Sowerby.
" probably *O. calligramma*, Dalman.
" " *O. Davidsoni*, De Verneuil.
Atrypa reticularis, L
Pentamerus, allied to or identical with *P. oblongus*, Sowerby.
Calymene Blumenbachii? Brongniart.

Coral conglomerate at Ste. Blandine

Another and still more prolific locality occurs directly by the roadside, about a quarter of a mile south of Ste. Blandine Church. The ledges here, which dip. S40°E < 40° 50°, may be well called a coral conglomerate, as they are higher in the series, and are literally filled with fossils. From them the following forms have been obtained:

Fossils from Ste. Blandine.

POLYPI.
Favosites Gothlandicus, Lamarck.
Halysites catenulatus, L.
Cyathophyllum, cf. *C. Pennanti*, Billings.
Syringopora retiformis? Billings.

CRINOIDEA.
Numerous fragments of Crinoids.

BRACHIOPODA.
Strophomena rhomboidalis, Wilckens.

Orthis varica, Hall.
" sp. indt.
Rhynchonella nucleolata, Hall.
Spirifera cycloptera, Hall.
" sp., cf. S. *sulcata*, Hisinger.
Retzia or *Trematospira*, sp. indt.
Atrypa reticularis, L.
Merista arcuata, Hall.
" *princeps*, "
" *levis*, "
Pentamerus galeatus, Dalman.
" n. sp.
Tentaculites sp., indt.

GASTEROPODA.

Euomphalus carinatus? Sowerby. A large form with obscure markings. May be *E. rugælineata*, Hall (24th Reg. Rep. p. 186).

TRILOBITA.

Acidaspis sp. indt. Hypostome.
? *Lichas* " "

The above were collected by Prof. Bailey, and determined by Mr. H. M. Ami, who subsequently added the following :—

A stromatoporoid.
Favosites, sp., with small corallites.
Syringopora, resembling S. *junciformis*, Hall.
Impression or cast of a scapular plate of a cystidean allied to *Caryocrinus*.

Relation of the beds.

Owing to the character of the ground, the precise relations of these several fossil-bearing beds are not easily determined. It is certain that the rocks containing the species in the list last given are above and not far removed from the beds which form the summit of Mt. Bois Brulé, while those yielding the species enumerated on p. 18 M represent still lower beds. The white sandstones are not visible here, being probably concealed by the talus on the north side of the mountain, but they are described in the Geology of Canada as seen on the Rimouski River. To the south of the coral conglomerates, the exposures are frequent, consisting chiefly of grey calcareous and buff weathering sandstones, with some limestones, which may be seen for several miles along the road leading back from Ste. Blandine to the Taché road. They dip very regularly S 40° E < 20°—40°, and occasionally hold remains of crinoids and ribbed shells.

Road back from Ste. Blandine.

Quatawamkedgwick and Rimouski rivers.

Northern edge of the Silurian. From the Rimouski River at Ste. Blandine, six miles in a straight line from the shore of the St. Lawrence, the northern border of the Silurian plateau bends rapidly to the south and west, and, as described in the Geology of Canada, is next prominently seen on Lake Temiscouata. Between these two points, however, there is an interval of fifty miles, and with a view of obtaining more accurate knowledge of the country separating them and of the formations included in the interval, two traverses were undertaken, the one embracing the section drained by the Rimouski and Quatawamkedgwick rivers (the latter a branch of the Restigouche); and the other a similar section afforded by the branches of the Trois Pistoles and Tuladi rivers, the latter connecting with Lake Temiscouata. Mr. McInnes, by whom these traverses were made, thus describes the facts observed.

Quatawamkedgwick river. Along the lower part of the Quatawamkedgwick River, for the first few miles, the strata are a continuation of those seen along the main Restigouche River, between the Gounamitz and the mouth of the Quatawamkedgwick. They consist in the main of grey calcareous slates, with bands, half an inch to six inches in thickness, of impure limestone, and with interstratified beds of hard sandstone.

Anticlinal folds. The sandstones are seen at points three and five miles from the mouth of the river, forming the sides of an anticlinal fold, the lower exposure dipping S.56°E. < 85°, and the upper exposure N.46°W<80°. Overlying these sandstones, and exposed on the river above and below them, are grey calcareous slates, with limestone bands from half an inch to three inches in thickness; and underlying them, brought up by the fold, are grey calcareous slates again showing the limestone bands, more sparingly, however, and only in the upper beds, near the sandstones. Farther down on the river, within a quarter of a mile of the Restigouche, these sandstones, or beds of a similar character, are exposed again, apparently brought up by a fault; they are in direct contact with the banded states and cut off the beds, which are much bent and twisted at the point of contact, and have white calcite scattered through them in numerous veins and lenticular patches.

Fault (?)

Banded slates. Grey, calcareous slates, without the conspicuous banding before noted, occur all along the river in a succession of low undulations to and beyond the main forks. The bedding of these rocks is seldom clearly seen, a strong and nearly vertical cleavage everywhere obscuring it; they are crumpled into a series of folds striking N. 50°E. to N. 70°E., but show local twisting of the most fantastic kind, and resemble quite closely the contorted slates which occur along the shore of Temiscouata Lake between Notre Dame du Lac and the foot of the lake.*

*Geology of Canada, 1863, pages 424 and 425

Hard, dark blue slates, with softer, fissile bands, not differing in any great degree from those seen below, extend up the river as far as the crossing of the boundary line between New Brunswick and Quebec; like the slates described above, they are cut by a nearly vertical cleavage and are folded in a like manner to them; the softer, more fissile portions of the ledges weather out readily, and leave the harder bands projecting in a succession of knife-like edges in the bed of the stream. For a distance of two miles and a quarter below the boundary line, the outcrops seen along the stream dip about N.45°E. < 30°-40°, indicating the occurrence here of a long dome in the rocks, the summit of which would lie some distance to the south-west of the stream. Above the boundary line no exposures are seen for a mile, or until the first fall is reached, where the following section is exposed, measuring at right angles across the strata which dip N.5°E. < 90°:

Strata at provincial boundary line.

Fossiliferous strata.

	FEET.
Dark blue, finely micaceous, shales	10
Shales, similar to above, with bands of light grey, finely micaceous sandstone, with carbonaceous markings resembling plant remains, but too fragmentary for determination	10
Soft, grey, calcareous shales	3
Soft, grey, calcareous shales, and finely micaceous, grey sandstone in thicker beds, with crinoid stems and shells	20
Sandstone in heavy beds, with thin bands of soft, grey shales	25
Sandstone in heavy beds, weathering to a rusty, buff-colored, rotten stone with thin bands of shale, very fossiliferous in certain layers, especially along the junction planes of the sandstones and shales	30
Soft, dark blue shales and beds of sandstone	50
Soft, dark blue shales and beds of sandstone with fossils in certain layers	250
Dark grey shales, forming falls four feet high	10
Same shales	150

A small collection of fossils from this locality, which has been examined by Mr. Ami, contains the following species:—

List of fossils.

Obscure *Psilophyton* or plant like remains.

Numerous crinoidal joints.

Orthis sp., of the type of *Orthis rustica*, Sow.

Strophomena sp., with peculiar vermicular parasitic (?) organisms attached to the outer test of the individual.

Spirifera sp., cf. *S. Nictavensis*, Dawson, and *S. arenosa*, Conrad.

Lichas (?) or some closely related genus of trilobite.

The collection is scarcely sufficient or characteristic enough to state definitely whether the rocks from which it was obtained belong

to the upper portion of the Silurian system or to the base of the Devonian.

Lithological character.

These beds resemble in general lithological character the fossiliferous strata occurring near the edge of the Silurian on the Beccaguimic and elsewhere.*

Beyond this fossiliferous band no exposures are seen in place for a distance of about ten miles along the stream; large angular blocks of a very hard, grit-like, grey sandstone are plentiful at a point about three miles above the boundary line, but the first exposure *in situ* occurs about a mile and a half below the lake, where ledges of finely micaceous, soft, blue slate, with layers of limestone, weathering into depressed bands and nodules, strike N.59°E. At the upper forks, half a mile below the lake, a ledge of the same character occurs, and again about half-way down the lake a similar ledge of highly calcareous, rusty blue slate, of nodular structure, weathering into irregular ridges with pitted depressions between, and with black films along the cleavage planes, forms a reef in the lake, and is exposed on the western shore on the line of strike, which is N.49°E.

Upper forks.

Kedgwick Lake

This lake, known as Kedgwick Lake, is two miles in length and has an average width of about half a mile; it is quite shallow, and the immediate shores are flat and swampy. Low hills wooded with spruce and cedar rise about a mile back from its shores. A stream entering near the head of the lake flows from a smaller lake with the same general features. No rock occurs in place either on the stream or around the shores of the second lake; large blocks of coarse sandstone or fine conglomerate, holding small pieces of black slate, are common about the foot of the lake, and near its head, grey, fine, calcareous, arenaceous sandstone, weathering rusty, pitted in certain layers and slaty in places, similar to that described above as occurring in place on the stream, is strewn over the lake bottom in large angular blocks.

Portage to small lake on Rimouski River.

From this lake, a portage of a mile and a quarter, over a low ridge, wooded with white birch, cedar and spruce, leads to a small lake at the head of the left hand branch of Rimouski River. The only exposures seen on this lake are at the narrows, three-quarters of a mile from its head; they are soft, grey, calcareous slates with narrow black bands, which give to the ledges a ribanded appearance; the beds are considerably twisted, and are cut by a large vein of white quartz. Large angular blocks of the fine conglomerate, mentioned above, holding small pieces of soft, black slate, occur in numbers at this point.

Ribanded slates

The stream draining the lake is very small, and flows through flat,

*The Silurian system of Northern Maine, New Brunswick and Quebec. L. W. Bailey. Trans. Roy. Soc Can., 1886, Sec. IV., page 33. Annual Report, Vol. I., 1885, page G 14 et seq

swampy land for about two miles below the lake, showing no exposures. For part of this distance, however, the stream is choked with large blocks of coarse sandstone and conglomerate, the latter holding pebbles of limestone. Descending the stream, the first exposures, which occur about a mile and a half below the lake, are rusty-weathering, soft, dark-grey slates, with satin-like surfaces and showing fine black banding; the bedding is cut obliquely by an almost vertical cleavage. These beds are followed, at a distance of two miles farther down the stream, by soft, finely micaceous, dark-grey slates; no general dip could be got on account of the violent crumpling to which the beds have been subjected. Angular blocks on stream.

After leaving the lake, the stream runs in a general north-westerly direction for a distance of about seven miles, it then turns with a sharp loop to the south-southwest, and preserves that direction in a general way for ten miles, to its junction with the right hand branch of the Rimouski River. On the eastern side of the bend no ledges are exposed; near its apex and for some distance to the south of that point, large blocks of hard conglomerate and sandstone are thickly scattered along the bed of the river. The section seen between the northern point of the loop and the Rimouski River supplies the place of that concealed along the upper part of the stream, the strike of the strata carrying them across both sides of the bend; the exposures consist mainly of very highly crumpled, grey, calcareous slates, with bands of limestone and occasional beds of sandstone. Taking up these beds in order towards the north, or in the reverse order to that in which they are seen in descending the stream, we have, two miles above the forks, an anticlinal fold with dark grey slate at the summit, and on either side slates, with interstratified bands of hard sandstone, ten inches in thickness. Following these are dark grey slates again, bent and contorted, dipping south; and beyond, another anticlinal fold, shewing slates with hard sandstone bands two to three inches in thickness, and hard, grey silicious sandstone, with fine, hair-like, black markings and cut by veins of mixed calcite and quartz, and by large veins of rusty-weathering, white quartz. These beds are much twisted up and altered by compression, the slates becoming quite ligniform in structure where they adjoin the beds of sandstone. General course of the stream. Section seen on left hand branch.

On the main Rimouski River, strata similar to those above described occur all along down to the great falls. They are mainly grey, calcareous slates, with limestone bands, and with, here and there, interstratified bands of hard sandstone. Rimouski River beds.

The whole series of rocks above described has been subjected to very violent crumpling, the strata exposed along the main Rimouski River shewing its effects more particularly. The folding is often of the Crumpling.

most fantastic description, shewing local dips towards every point of the compass and at every angle, but preserves a general parallelism in the trend of the folds, which run roughly north-east in broad curves. A fine and strong vertical cleavage, which cuts the slates, strikes in the same direction; this necessarily cuts the planes of bedding at various angles, and renders the finding of fossils in the strata extremely difficult.

Vertical cleavage.

Effects of pressure.

The planes of cleavage become co-incident with those of bedding only in close proximity to comparatively thick beds of sandstone, which have proved rigid enough to withstand the cleaving action of the above, and to induce in the adjoining slates a cleavage parallel to their own bedding; a further effect of the greater resistance of these beds of sandstone is seen in the production in the slates near them of a ligniform structure. The extreme phases of crumpling have occurred near the centre of broad bands of slate, where the twisting and distortion of the beds has been very great, and where a conglomerate, similar to that seen at the mouth of the Seigas stream, on the St. John River,* has been formed.

Formation of conglomerate.

This conglomerate is made up of sub-angular pieces of impure limestone, imbedded in a matrix of calcareous slate; the enclosed fragments are often very considerably rounded, and the rock might in places be readily mistaken for a conglomerate with water-worn pebbles; in other places, however, the method of its formation is clearly shown. It has evidently been formed from slates, with interstratified, harder bands of limestone, which have been subjected to great lateral pressure. The softer slates have bent and stretched under the force exerted, while the harder bands have broken up, and, after having been partially rounded by attrition, have been surrounded by the slates, which have curved around the broken pieces and filled the interstices between them, producing, on a large scale, a structure similar to that induced by flow.

Trend of folds.

The general north-east and south-west trend of the whole series of folds, and the parallelism to these of the planes of cleavage, would indicate the operation of a force acting at right angles to this direction, or from the south-east or north-west, and at right angles to the coast line to the south, and to the edge of the Laurentian Hills to the north.

The description which has been given above of the rocks exposed along the Rimouski River has been carried northward down the river only as far as the head of the Great Falls gorge; the section which the river affords, between the foot of the gorge and the St. Lawrence, has been described in the Geology of Canada, 1863, pages 418 and 419.

* Geology of Canada, 1863, p. 426.

The Silurian age of the rocks described in the above section extending from the Restigouche River westward on its tributary the Quatawamkedgwick as far as the fossiliferous strata above the provincial boundary line admits of little doubt, as, although fossils were found in them only at the one point mentioned, they are evidently, from their lithological character and stratigraphical position, the continuation eastward of the strata exposed along the St. John River. They are therefore considered to be Silurian, and probably of about the horizon of the Lower Helderberg. Silurian age of beds on the Restigouche.

There is less certainty with regard to the age of the rocks exposed along the Rimouski River and extending across the height of land to Quatawamkedgwick; no fossils have been discovered in them between the Taché Road, where the rocks are fossiliferous and of Silurian age, and the fossil-bearing ledges above referred to as occurring near the provincial boundary line. The whole extent of highly disturbed beds intervening cannot therefore, with any certainty, be assigned to a particular horizon, and the question as to whether they are of Silurian age or otherwise is left until the work of another season shall have afforded fuller evidence on the point. The parallel section further to the west, to be presently described, shows no strata further north than the Mt. Wissick ridge, which can be classed with any certainty as Silurian. Doubtful age of the Rimouski beds.

The Quatawamkedgwick River flows in a deep valley about half a mile in average width, and sweeps from side to side of this valley, leaving on either side between the bends, flat land, extending back to the hills which rise along the lower part of the river to a height of from 400 to 500 feet above its bed. The water is exceedingly clear and cold and the current very swift, with no stretches of dead water; fine deep pools, however, occur here and there along its course, which form the spawning beds of large numbers of salmon and trout. Small islands, wooded with balsam poplar, elm and ash, are plentiful along the lower stretches of the river, and the scenery all along is strikingly beautiful. Valley of Quatawamkedgwick.

The appropriateness of the Indian name, Quatawamkedgwick (the river which runs down hill and disappears under the ground), becomes apparent at many points along this part of the river's course, where the water, always swift, seems literally to run down hill, and to disappear under the mountains, towards the base of which it again and again flows, and only turns abruptly off when to all appearance on the point of disappearing beneath them. Derivation of name.

Higher up, the valley gradually becomes narrower, and the confining hills loftier, rising to heights of over 700 feet above the river bed. Elevations of various points along the valley and of many of the Height of hills.

neighbouring hills are given by Mr. Chalmers in the annual report for 1886. The general character of the valley remains the same up to within a few miles of the main forks; above this point, the hills on either side gradually disappear and the country bordering the stream becomes flat and continues so to the lakes which lie at its source.

Watershed.

These are divided from lakes draining into the Rimouski by only a low ridge, and the whole extent of country lying about the headwaters of these rivers is generally of even surface with large areas of swamp and with few elevations rising to any considerable height above the general level. Evidence that this level land which forms the central water-shed was once covered by glacier ice is afforded by the deposits of boulder clay which occur at different points. A deposit of this nature, noted by Mr. Chalmers,* occurs two miles and three-quarters below McDougall's Brook, and is here overlaid by a stratified bed of sand and gravel. Boulder clay was noted at two other points further up on the stream, one of these was at a bend in the river, a quarter of a mile above the crossing of the provincial boundary line, and the other a quarter of a mile below it. At these points the river washes against, and cuts into, a bank of unstratified clay from twenty to thirty feet in height, holding pebbles and small boulders of the local rock with smoothed and flattened sides longitudinally striated; the overlying stratified sands and gravels, which occur in the exposure below, are here entirely wanting, only a thin layer of loam covering the clay. The stream at the crossing of the boundary line is probably about 150 feet higher than at the boulder clay deposit below McDougall's Brook, or, taking the heights of the latter place given by Mr. Chalmers, 570 feet above sea level.

Evidences of glaciation.

Boisbouscache and Tuladi rivers.

Trois Pistoles and Tuladi Rivers.

A second traverse was made across the watershed south of the St. Lawrence, by way of the Trois Pistoles and Tuladi rivers and their branches. The Boisbouscache or left hand branch of the former river was followed from the settlement of St. Jean de Dieu upwards for a distance of eight miles. From this point Lac des Iles at the head of the left hand branch of Tuladi River was reached by a short portage. The road which leads back from Trois Pistoles Station to the settlement of St. Jean de Dieu, a distance of twelve miles, passes over a succession of low rolling hills, rising gradually from the St. Lawrence, and crosses alternately belts of hard siliceous sandstone (so-called Sillery) forming the higher hills, and green and purple slates (so-called Lauzon) occupying the intervening valleys. These rocks

St. Jean de Dieu.

*Annual Report, 1886, page 15, M.

are all very much altered and contorted; they have been treated of at length in the Geology of Canada, 1863, and in the subsequent reports of the Survey by Dr. Selwyn and other writers; further details with regard to them are left for a later report when the structure shall have been more thoroughly worked out; all that will be attempted now will be to describe the exposures observed along the streams traversed on this route. Earlier reports.

Ascending the stream from the settlement of St. Jean de Dieu, the first exposures seen form a low fall about 200 yards above the main road bridge; they are hard, dark grey, compact sandstones, considerably contorted, and dip S. 19° W. <80°. The next exposures, which occur about half a mile beyond, are hard, grey, rusty-weathering, highly altered, nacreous slates, locally much folded, but keeping the same general dip; further on, however, the same slates dip S. 20° E.< 45°–50°. Similar sandstones and hard, grey slates continue in alternating bands beyond this point, preserving the same general strike, but shewing also local dips in various directions and at all angles from horizontal to vertical. The slates in places are banded with green, and are everywhere highly altered and contorted, and often finely cleaved with shining, satiny surfaces along the planes of cleavage. The last exposures seen on the stream occur just at the mouth of a small brook, entering on the left bank, which drains the lake through which the portage to Lac des Iles passes; they are sandstones and soft red and greenish-grey slates, with soapy feel and with limestone bands, two inches in thickness, interstratified. The same slates again appear in a low bluff on the right hand side of the portage, about three-quarters of the way across, dipping S.E.<70°. Section seen along the Boisbouscache.

Lac des Ilets is a small, shallow lake, about two miles and a half in length, and has an average width of a quarter of a mile; the shores are quite low and show no exposures of rock *in situ*. Lac des Iles

A number of small islands at the narrows, near the head of the lake, are formed of angular blocks of dark grey, hard, siliceous sandstone, which probably occurs in place beneath or near at hand; the nearest exposure of this sandstone seen, however, crops out on the stream (Rivière St. Jean) three-quarters of a mile below the lake, where it dips N.38°W.<65°. A mile below, hard, grey sandstone, composed largely of quartz grains, with some felspar, and with small pieces of black slate, dips N.41 <90°; and beds of the same character, but greenish in color and associated with hard, grey slates, crop out on the stream about a third of a mile below, and dip in the reverse direction at a very high angle. A quarter of a mile further down, the same hard sandstones and slates, with hard, very dark grey, splintery shales, dip N.30°W.<85°; these are followed Rivière St. Jean.

about half a mile below, by a repetition of the beds of sandstone seen above, which hold pieces of soft black slate. From this point to within two miles of Lac des Aigles no exposures are seen, then for three-quarters of a mile the stream flows over almost continuous exposures of calcareous sandstone, with white calcite along jointing planes, and calcareous slates with hard, flinty, calcareous bands, half an inch to two inches in thickness. These beds have a general dip, as nearly as could be determined, N.50°W.<80° ; they are, however, very violently twisted and contorted, so that deviations from this general dip are very frequent. The lower quarter of a mile of this long exposure is occupied entirely by the banded slates, which terminate abruptly in a ledge which crosses the river nearly at right angles to its course and forms a fall six feet in height. No exposures appear along the stream from this fall down to the lake, a distance of one mile. A short distance above the fall, boulders of red slate, about eighteen inches in diameter, occur in the bed of the stream, together with larger, well-rounded boulders, perhaps six feet in diameter, of highly calcareous nodular sandstone, with broken bands of limestone, and containing many large corals resembling *Favosites Gothlandicus*.

Fall

Fossiliferous blocks.

The sandstone of these blocks closely resembles that of the beds of similar character, which make up the mass of Mount Wissick on Lake Temiscouata,* and the blocks themselves are probably derived from the north-eastern end of the ridge of which Mount Wissick forms the south-western termination.

Age of the Boisbouscache River rocks.

Of the strata above described the whole series occurring along the Boisbouscache River is, with little doubt, a continuation and partly a repetition of that observed along the road leading southward from Trois Pistoles station, and the set of beds observed along the Riviere St. Jean, between Lac des Ilets and Lac des Aigles, an extention northward of those which occur along the shores of the northern arm of Lake Temiscouata, and which, as described elsewhere in the present report, underlie the fossiliferous strata of Mt. Wissick. The whole section southerly to the ridge which forms the north-easterly extentation of Mt. Wissick, would thus seem to embrace only rocks of Sillery (Upper Cambrian) age.

Lac des Aigles.

The immediate shores of Lac des Aigles are quite low, and no rock in place was seen on the lake.

Rushes and water lilies grow in profusion around the lake shores, and often extend far out into its waters, which are quite shallow. The stream draining the lake also flows through flat land, and joins the Horton branch of the Tuladi River about half a mile above the junction of that branch and the Squatook branch.

* Geology of Canada, 1863, p. 421

The Tuladi is a remarkably smooth-flowing river without falls or rapids, with the exception of one small fall just below the first lake and a short rapid above its mouth. Tuladi River.

Fine flats occur at many points along its course, indeed the whole tract of land along the river seems to be of excellent quality. Good land.

The traverse which has been described follows an old Indian route, which once formed one of the main highways of communication between the St. John River and the St. Lawrence. Two of the old camping places on the route, which are now over grown with quite large trees were visited; one of these is situated on a point on the south shore of Lac des Aigles, opposite the mouth of the inlet from Lac des Ilets, and the other is on the left bank of the river at the foot of First Tuladi Lake. The latter place has evidently been a favourite one for the manufacture of flint implements, as the surface over a considerable area is dotted with little piles of flint chips. The material used must have been derived from the drift, as no suitable rock occurs in place in the vicinity. Old Indian route. Flint chips.

The exposures occurring on the lake and at the rapids in the lower part of the river are described in another part of this report.

Lake Temiscouata.

The rocks of Lake Temiscouata have been described in considerable detail, and are given with sections illustrating the relations and probable thickness of the principal beds in the Geology of Canada, 1863, pages 419–425. It is with pleasure that we bear testimony to the general accuracy of these descriptions, which, so far as the lithology of the rocks is concerned, leave little to be desired. A careful review, however, of the admirable but complex section here revealed has enabled us to add very considerably to the lists of organic remains in the beds already known to be fossiliferous, as well as to record their presence in certain portions of the series in which they had not previously been observed; while the exploration of the surrounding country and the comparison of this with districts studied elsewhere, have served to throw new light on points hitherto obscure. The following section is a condensation of that in the Geology of Canada, with such additional information as has been recently obtained. The section begins on the north side of Mount Wissick or Mount Lennox, where the rocks of the Silurian system may be seen to rest unconformably upon those of the "Quebec group":— Lake Temiscouata. Accuracy of section in Geology of Canada, 1863. Condensed section of Mt. Wissick beds.

Greenish grey and black slates, alternating in thin bands, two to three inches wide, with grey or buff weathering dolomitic limestones. These beds occur on the north-east side of a small cove above Mt.

Condensed section of Mt. Wissick beds.

Wissick, and are a part of a similar series of rocks, supposed to be of the same age as those of Point Levis which occupy all the upper part of the lake. They have been subjected to much crumpling, and exhibit considerable irregularity of inclination, their dip, where nearest to the Silurian, being N.40°W.<70°–80°. They have as yet yielded no fossils, and their thickness is unknown.

Measures concealed for about half a mile.

Grey quartzose sandstone, containing white quartz pebbles, mingled with fragments of limestone in a greenish sandy matrix. These grits or conglomerates apparently occupy a space across the measures of about 1,000 feet, and with a dip of S.65°E.<40° would give a thickness of.......................................642 feet.

White sandstone or quartzite in massive beds. These rocks are grey within, but weather almost snow white, with vitreous surfaces, often drusy with small quartz crystals. Some portions are pinkish or reddish, and others spotted with small red dots. Their thickness, as given in the Geology of Canada, is only 40 feet, but they were found to have a surface breadth of 250 paces, which, with an average dip of 60°, would give a thickness of....................420 feet.

Coarse, shaly and rubbly conglomerate, holding limestone pebbles (with some quartz). They dip S.60°E.<70°, and have a breadth of 80 paces, corresponding to a thickness of ....114 feet.

Dark grey sandstones. Dip S.70°E.<20°. Thickness about....10 feet.

Grey calcareous shales, filled with bands, nodules and lenticular masses of limestone, abounding in fossils. Among these are the following:—*Favosites Gothlandicus*, Lamarck ; *Chaetetes* sp. or *Dendropora ; Zaphrentis* sp. ; Crinoidal fragments ; *Chonetes ; Strophodonta varistriata*, Conrad ; *Rhynchonella nucleolata*, Hall, *R.* sp. indt. ; *Atrypa reticularis, L. ; Meristella* or *Merista*, very abundant, and including three species, *M. bella*, Hall, *M. laevis*, Vanuxem, *M. didyma*, Dalman ; *Megambonia* sp. ; *Grammysia* sp., resembling *G. Acadica*, Billings ; *Orthonota*, sp. ; *Cucullella* sp. ; *Orthoceras*, with large siphuncle on one side, ten septa in the space of seven centimetres, and seven septa to its own diameter ; *Cornulites flexuosus*, Hall ; *Calymene Blumenbachii*, Brongniart ; *Beyrichia tuberculata*, Kloden, typical examples, and in great abundance ; *Proetus ?* sp. indt.

These beds are regarded by Mr. Ami, by whom the fossils have been examined and in part collected, as corresponding to the Chat River limestones, equivalent to the upper part of the Chaleur group, and about equivalent to the lower part of the Lower Helderberg formation. Dip S.65°E. <60°. Thickness about.....10 feet.

Red and green shale, in alternating bands, with green argillaceous sandstones. The dip of these beds where they overlie those last mentioned is S.65°E.<15°, their strong slaty cleavage having an underlay of N.65°W.<80°, but in following them along the precipitous face of the mountain, they are found to fold over and exhibit a dip N.40°W.<40°. They are also broken by a fault. Their estimated thickness is..125 feet.

Condensed section of Mt. Wissick beds.

Grey nodular limestones, conspicuously divided by vertical joints, which often present curved surfaces and produce an appearance resembling that of fluted columns. These beds rest directly upon the red and green shales, and are probably arched with them, but towards the southern end of the bluff resume their normal dip S.65°E. at an angle of 50°. The columnar limestones, which contain but few fossils, have a thickness of about 10 feet, and are followed by about the same thickness of finely banded massive limestones, having at the top a zone, from one foot to 18 inches thick, filled with branching corals, chiefly *Favosites*—it also holds shells of *Atrypa reticularis* and *Pentamerus*. This is capped by more columnar limestone, the whole having an aggregate thickness of about.............. 50 feet.

Grey hard sandstone, with beds of impure limestone, the sandstone containing remains of *Meristellae*,..............................30 feet.

Grey nodular limestone, without observed fossils.....................30 feet.

Grey banded limestone, filled with corals and other fossils, including *Favosites Gothlandicus*, Lamarck; *Strophodonta varistriata*, Conrad, in great abundance and forming the typical representative of the zone; *Grammysia*, sp., resembling *G. Canadensis*, Billings; *? Megambonia mytiloidea*; *Euomphalus*, resembling a species obtained by Dr. Ells from the forks of the Scaumenac river; *Leperditia*, a narrow reniform species, having a length two and a half times its breadth; *Alveolites* (?) sp. indt.; *Zaphrentis*, sp. indt.; *Orthis* sp.; *Rhynchonella formosa*, Hall; *R. Wilsoni*, Sowerby; *R. nucleolata ?* Hall or a very closely allied species; *Merista* sp. *? Pterinea* sp.; *Anodontopsis* sp.; *Megambonia* sp.; *Orthonota* sp.; *Leperditia*, sp.; *Beyrichia Kloedeni*, Sowerby or a variety of that species; *Beyrichia* sp. allied to *B. equilatera*, Hall; *Beyrichia*, a third species, elevated and globose, not recognized as a described form; *Calymene*, like *C. Blumenbachii*, Brongniart

[Mr. Ami considers these fossils also to indicate the horizon of the lower portion of the Lower Helderberg series. The authors were assisted in the collection of the fossils by Mr. Ami and Mr. W. T. H. Reed.] Thickness about...30 feet.

Grey arenaceous limestones and sandstones forming the upper portion of Mt. Wissick, but sloping to the level of the lake, with a dip S.70°E. <13°. These higher beds contain comparatively few fossils, among which are the following: A stromatoporoid form; crinoidal fragments, in abundance; *Chonetes*, sp., a rather arcuate form, smaller than *C. Nova-Scotica*, Hall, and larger than *C. tenuistriata*, Hall, resembling somewhat *C. Melonica*, Billings; *Meristella*, sp. Their supposed thickness is about..................................500 feet.

The beds may, therefore, be correlated with the Lower Helderberg or with the Ludlow formation of Britain.

Mt. Wissick.

The eminence of Mt. Wissick, including the above section, is situated on the eastern side of Lake Temiscouta, near the angle between the lower and upper portions. On the western side of the lake and opposite the mountain, the only trace of this great series of beds is to be

found in a few outcrops of fossiliferous shale, occurring on and near the Portage road, about a mile northward of the village of Cabano. There is in this village also a considerable mass of white sandstone or quartzite, bearing much resemblance to that at the base of the mountain, but it equally resembles other great masses of rock a few miles to the north, which have been supposed to represent the Sillery formation of the Quebec group. These have a much higher dip than any of the beds of the mountain, and are probably correctly referred to the older series.

White sandstone at Cabano

Black and Burnt Point conglomerates.

Between the highest beds of Mt. Wissick and those of Black Point, the first exposure to the south, there is a sufficient interval for 1276 feet of strata with the dip above given (Geology of Canada, page 421). In the rocks of this point, however, and its counterpart, Burnt Point, on the opposite shore of the lake, not only does the character of the beds become greatly altered, but their inclination is greatly increased, the coarse conglomerates of which they are composed now dipping S.50°E. <50°. Notwithstanding the enormous thickness of these conglomerates, by estimate nearly 1,000 feet, they would appear to be quite local, stretching eastward from the lake for a few miles only, and for a still less distance upon its western side, while there is but little to represent them over other portions of the Silurian area. This fact, in connection with others to be presently noticed, favors the idea that these conglomerates with some of the succeeding beds are older than those of Mt. Wissick and that the interval above alluded to marks the course of an upthrow fault. So far as the conglomerates are concerned, we have failed, after repeated search, to find in them any remains by which their age can be determined*. In the soft, grey, slaty and sandy beds which succeed them, we have, however been more fortunate, and have obtained a considerable number of fossils, which appear to indicate that the beds belong to a lower horizon than those of Mt. Wissick. These fossils were collected (by Messrs. Reed and Ami, with the authors) upon the western shore of the lake just above Pointe aux Trembles, and partly from the hard sandstones of the point itself. From the shales were obtained crinoidal columns with shells of *Leptaena transversalis*, Dalman, a *Rhynchonella*, sp. indt. and also an *Orthoceras* of small size.

Thickness.

Upthrow fault.

Fossils in shales

Pointe-aux-Trembles fossils.

In the sandstones were found the following species:—

POLYPI.

Streptelasma, sp. indt. A rather large or straight form, showing some resemblance to *Petraia rustica* of Billings.

* Fossils are said to have been obtained from the limestone pebbles of these conglomerates many years ago by Mr Billings, but so far we have failed to find any.

BRACHIOPODA.

Lingula, sp. indt.

Orthis, sp. indt., apparently allied to *O. hybrida*, Sowerby, or *O. elegantula*, Dalman.

Platystrophia biforata, Schlotheim, var. *lynx*., Eich.

Strophomena, sp., of the type of *S. alternata*, Conrad.

Rhynchonella, sp.

Triplesia ? sp.

GASTEROPODA.

Pleurotomaria or *Platyostoma*.

Murchisonia sp., an apparently young shell, with comparatively large body-chamber, and small acute spire.

PTEROPODA.

Hyolithes (*Theca*) *Forbesi*, Sharpe. A specimen which resembles the species found in the Silurian of Arisaig, N.S., and here identified with *H. Forbesi*.

CEPHALOPODA.

Orthoceras, sp. indt.

These fossils suggest the idea that the rocks from which they were obtained are about the age of the Niagara Limestone.

Volcanic activity.

It is important to notice in connection with the Pointe aux Trembles sandstones the evidence which they appear to afford of contemporaneous volcanic activity. This is, perhaps, partly indicated by the colour of the rock, which varies from green to red and purple, but is more clearly seen in the abundance of epidote with which the rock is charged and, in places, its somewhat amygdaloidal aspect. Much of it is a conglomerate rather than a sandstone, the pebbles and paste being much alike in character, and both somewhat porphyritic. The presence of bands of purplish black jasper is also a noticeable feature.

The rocks above described, in addition to their somewhat conspicuous display on the shore of the lake at Pointe aux Trembles, are also well seen along the course of the Tuladi River, the first mile of this stream being over the green and reddish sandstones, here dipping S.50°E.<75°–80°, while at the Tuladi Falls and in the rapids above, the rocks are the grey, sandy shales and sandstones, with coarse grey grits, holding fragments of black slates and yellowish weathering dolomite, having a pretty uniform dip of S.65°E.<70°. In black splintery shales near the falls graptolitic fragments were found by Mr. Reed, apparently of the genus *Diplograptus*.

Graptolites.

Fossils from First Taladi Lake

Following the course of the beds the same strata come out upon the shores of the First Taladi Lake, where they again contain numerous fossils, indicative of their age. The following were obtained from soft, grey shales, forming low ledges along the western shore of the lake, about half a mile above the outlet, and in a position corresponding to that of the fossiliferous beds of Pointe aux Trembles :—

BRACHIOPODA.

Orthis hybrida, Sowerby.
Orthis flabellulum ? var. ?
Spirifera or *Platystrophia*, possibly *P. biforata*, var. *lynx*, Eich.
Strophomena, sp.
Leptaena transversalis, Dalman.
Rhynchonella, sp.
Pentamerus ? sp.
Leptocœlia, sp.

LAMELLIBRANCHIATA.

Modiolopsis orthonota ? Conrad.
Modiolopsis, sp. indt.
Orthonota solenoides ?
Pterinea, sp. indt., showing coarse reticulate surface markings.

GASTEROPODA.

Bucania stigmosa, Hall. Two typical examples.
Murchisonia Conradi, Hall, or a closely allied species.
Murchisonia, sp., like *M. subulata*, Conrad.
Loxonema, sp.
Pleurotomaria cf. *P. Axion*, Hall, with fine cancellated markings on the shells, which are well preserved.
Holopea, type of *H. Harmonia*, Billings, but much smaller.
? *Turbo Octavius*, d'Orbigny, or *T. carinatus*.

TRILOBITA.

Portion of the pleuron of a trilobite.

These fossils probably indicate as low a horizon in the Silurian system as the lower part of the Niagara formation, or perhaps the Clinton.

Annelid trails.

These shales are followed here, as elsewhere, by sandstones corresponding to those at Pointe aux Trembles. They re-appear also on the south-eastern side of the lake, and are here remarkable as containing numerous tracks or trails of some marine animal, probably of an annelid. These tracks resemble those known from the Silurian rocks of Western

Ontario, as *Harlania* or *Arthrophycus*; also, and in a marked degree, those described by Mr. Whiteaves from Gaspé, under the name *Gyrichnites*. As the Lake Tuladi specimens most probably belong to the genus last named, the name of *G. minor* is here suggested for them by Mr. Whiteaves.

Squatook Peak

Still further east the same sandstones, with the same stratigraphical relations, and the same semi-volcanic aspect, come out upon and cross the main Squatook Lake, forming in addition to an island in the latter the remarkable hay-stack like mountain, known as the Sugar Loaf or Squatook Peak. No fossils were found in the sandstones of the mountain, but at its base, in a position corresponding to that of the shales described on Tuladi Lake, are numerous loose fragments of shale and sandstone, in which fossils are numerous. They are not well preserved, but among them the following have been recognised:—

Squatook Lake fossils.

Crinoidal fragments.
Zaphrentis, sp. indt.
Favosites.
Halysites catenulatus, L.
Orthis, sp., of the type of *O. hybrida*, Sowerby.
Strophomena, sp.
Leptæna transversalis, Dalman.
Spirifera plicatella, var. *radiata*, Sowerby.
Goniophora, sp.
Straparollus, sp.
? *Holopea*, sp.

These fossils are of about Niagara or Wenlock age.

Stratigraphical position.

The series of rocks above described, extending from Pointe aux Trembles up the Tuladi River to Squatook Mountain, though stratigraphically occupying a position which would seem to make them newer than the rocks of Mount Wissick, are thus throughout characterized by a fauna indicative of a lower horizon. We hence regard the Mt. Wissick beds as having been brought to the surface by a fault running just north of and parallel to the conglomerates of Black and Burnt points, which would thus become the true base of the Silurian system. The further fact that the strata of Mount Wissick rest directly upon rocks of the Quebec group, and have a comparatively low inclination, would indicate that this break occurred prior to the deposition of the Mount Wissick beds, and hence that the lower and upper portions of the Silurian system are here unconformable. Compared with the rocks of the Gaspé peninsula, those of Mount Wissick are evidently the representatives of those on the south side of the Shickshock Mountains, on

Fault and unconformity.

the Chatte and Matanne rivers, as also of those on Lake Metapedia, the Metis and Rimouski rivers. In this peninsula, as in Mount Wissick, the lower division of the system appears to be wanting.

Probable age of the slates.

The rocks which immediately succeed the Pointe aux Trembles, Tuladi and Squatook sandstones, referred to the Niagara formation, are the dark grey bluish-weathering and more or less calcareous slates which occupy the whole of the southern part of Lake Temiscouata, as well as the Madawaska River and a large section of the St. John, thence extending east and west over a large portion of northern New Brunswick and Aroostook county, Maine. The position of these slates in the Silurian system has not been certainly determined. At no point has their actual contact with the Pointe aux Trembles sandstones been observed, and though appearing to dip off from these, and conformably so (S.65°E.<70°), they are everywhere so extensively crumpled that but little reliance can be placed upon their attitude. Over the greater part of the area covered by them, they seem to be mostly destitute of fossils, and when these do occur, they are usually too few or too poorly preserved to indicate with certainty the exact horizon of the beds which contain them. The general aspect of these fossils, however, as indicated in earlier reports, is that of the Lower Helderberg group, and this and other facts render it probable that they represent the upper and more shaly portion of the Gaspé limestone series, being possibly the deep-water representatives of the latter. The only points where a lower horizon would appear to be indicated are the vicinity of the Siegas (or Shiguash) River, in Victoria county, N.B., and part of the valley of the Aroostook River, in northern Maine. As each of these localities has afforded us some information not obtained by previous authors, and as they have important bearings upon the geology of the whole region in which they occur, we now propose to give some of the results of their recent exploration.

Section in vicinity of Siegas River, Victoria Co., N.B.

Siegas River conglomerate.

In "Geology of Canada, 1863," p. 426, a section in the vicinity of the Siegas River is given, of which the most remarkable feature is the occurrence of a coarse conglomerate, said to bear much resemblance to that of Black Point on Lake Temiscouata. It is, however, very much thinner than the latter, the conglomerate proper not exceeding fifty feet, and is further characterized, in addition to pebbles of limestone, serpentine and jasper, which are in various positions, by what appear to be disjointed portions of limestone layers from half an inch to four inches in thickness and sometimes four feet long, which lie parallel to the stratification and occasionally curve with it. In following the beds

upon their strike these limestone bands or layers increase in number, and, with only thin, shaly partings, finally coalesce, or nearly so, into a bed, about forty feet thick, of tolerably pure limestone, used for burning; in which, however, each layer is still divided by numerous transverse breaks, into separate blocks. In the features thus described they appear to nearly resemble a portion of the Gaspé section, as described and figured on page 392 of the "Geology of Canada." We have been unable to find any fossils in these conglomerates, though they are stated in the work last referred to to contain them. In the examination, however, of the sandstone beds which are associated with and succeed the conglomerates on the south, we have found a fossil resembling the *Zaphrentis* from Squatook Mountain, together with the remains of an *Orthis* and a *Strophomena*, apparently *S. rhomboidalis*, Wilckens. These fossils, together with the character of the sandstones, which are often coarse and more or less vesicular, and nearly resemble those of Pointe-aux-Trembles, render it very probable that they are the equivalents of the latter, and belong to the lower or Niagara portion of the Silurian system. Their dip, like that of the conglomerates, is vertical (S. 40°–45° E. < 90°), and their breadth about a furlong. Beyond these are exposures of blue slates, which, at about the same distance, are succeeded by a second set of limestone beds, much like the first but purer, and which are also in a vertical position, with an exposed breadth of 150 feet. To these limestones succeeds the valley of the Siegas, beyond which there are no exposures as far as Grand River. South of Grand River the rocks are again slaty, grey, green and red argillites, with thin hematitic bands; their dip being N. 40° W. < 80°.

Fossils from Siegas River

Upper St. John and Aroostook Section.

With the several sections of the Silurian basin which have now been given, and which lie wholly within the territorial limits of Canada, we may finally compare still another. This section is parallel to but westward of that last described. It crosses parts of Quebec and New Brunswick, and also a considerable portion of northern Maine. Its comparison with those already given is desirable, not only from the peculiar geographical position of a portion of New Brunswick, which is, as it were, dovetailed between Quebec and Maine, but from the further fact that in the county of Aroostook, in Maine, the facilities for the study of the Silurian system are exceptionally good and help to throw much light upon the same system as developed in adjacent parts of Canada.

Upper St. John and Aroostook section

In passing to the westward from Lake Temiscouata, much difficulty is experienced from the comparatively level character of the country, and the want of exposures, in determining the character of the underlying rocks, or fixing their proper boundaries. It is, however, quite certain that the northern limit of the Silurian system, as given by Mr. Richardson (Report of Progress 1866-69, page 139) is, both on the Temiscouata Road and again on the St. Francis, somewhat out of place. As regards the first named road, the contact line with the Quebec group is both described and mapped as corresponding nearly to the position of the thirty-fourth mile-post in the settlement of St. Louis de Ha! Ha! Not only, however, are the slates at this point Cambro-Silurian rather than Silurian, but for three miles south-eastward of it great reefs of white sandstone and red slates are exposed to view which are unquestionably a part of the former system; the true line of contact is probably not more than a mile northward of the village of Cabano. So on the St. Francis, the limiting line between these two systems is placed at the head of Pohenegamook or Boundary Lake, whereas its true position, as correctly represented in the Geology of Canada (p. 426), is somewhere near and probably below the foot of the lake. The rocks which border Pohenegamook Lake, even to its southern extremity, are certainly those of the Quebec group, so called; but in exploring the adjacent country, the only beds by which the beginning of the Silurian could be determined were certain whitish-weathering sandstones which outcrop on a small brook in the vicinity of Cabano Portage. These appear to be lying at a very low angle and may possibly represent the white sandstones at the base of Mount Wissick, but no trace of any associated limestones or of any fossiliferous strata could be found, and beyond the fact of their being Silurian, little can be said as to their relations. Still further west similar difficulties were met with upon the Big Black and Little Black rivers, except that upon the latter, which is for the most part very tortuous and bordered by low swampy land, what would appear to mark the northern boundary of the Silurian occurs at its junction with its main or north-east branch about fifteen miles from the St. John River. The rocks at this point consist of dark purplish grey to black and somewhat graphitic slates, associated with beds of hard grey grit or sandstone which are in part conglomerates, and hold numerous fragments of black slate. Their dip is S. 60° E. < 60°. These are supposed to be of Silurian age, but differ in important respects from any portion of this system elsewhere seen. We were unable to penetrate above this point upon the Little Black for want of water.

Northern limit of the Silurian.

St. Louis de Ha! Ha!

Pohenegamook Lake.

Cabano Portage

Big Black and Little Black River.

To the south of the line above described, the whole country between the lower half of Temiscouata Lake and the Madawaska River upon the

one side, and the valley of the upper St. John on the other, appears to be entirely occupied by slaty strata. The conglomerates of Black Point and the sandstones of Pointe aux Trembles can be traced, for a short distance only, to the westward of the lake, and unless the former be represented by the beds referred to above on the Little Black are wholly wanting to the westward, as are also the limestones of Mount Wissick. The exposures of the slates on the other hand are numerous, especially along the valley of the St. John where they were frequently observed as high as the Seven Islands, eighty-five miles above Edmundston. They present in this distance but very little variation, except that they occasionally include beds of sandstone and have a nearly uniform bluish-black or dark-grey colour, which, by weathering, becomes greenish, or by action of water somewhat reddish in aspect. They are only slightly calcareous but are not unfrequently micaceous, their dark-green colour being apparently the result of finely disseminated chlorite. Owing to their strong slaty cleavage the true dip is not always easily made out, but when this is distinctly discernable it is usually at pretty high angles and sometimes nearly vertical, or with abrupt and intricate plications. Their western limit was not reached on the main St. John, but from such information as we have been able to obtain we think it probable that this limit is not far from, and has the general course of, the International Boundary, crossing the sources of the Big Black River and the north-west branch of the St. John a few miles west of Seven Islands.

Extension westward of Temiscouata rocks.

Seven Islands.

Limit of Silurian on upper St. John.

Aroostook County, Maine.

The area lying to the southward and westward of the St. John River comprising the county of Aroostook, Maine, is, like the adjacent parts of New Brunswick, largely occupied by slates. They cover the whole of the northern part of that county as seen on Fish River to Eagle Lake, and on the Alleguash for fifteen or twenty miles from its mouth and, with the possible exception of Mars Hill, are the only rocks seen along the International boundary as far south as Houlton; but a few miles to the westward these slates are interrupted by several bands which are quite different in character if not in age, and which are of much interest in their bearing upon the geology of New Brunswick and Quebec.

Aroostook section.

The first of these areas is a trough, or series of troughs, having a generally north-east direction and a length of about thirty miles, extending from Long Lake at the extremity of the eastern branch of Fish River, through Second or Mud, Cross, Square or Sedgewick and Eagle Lakes to Nadeau or Upper Lake on the main or south-western branch of the same

Fish River Lakes.

stream. At various points along the shores of these lakes the rocks are dark grey, bluish-weathering slates, not differing from those which elsewhere characterize the Silurian system, but with these occurs also a tolerably well-defined belt, consisting in part of reddish and chocolate brown shales and in part of grey grits and conglomerates, which are more or less fossiliferous and have associated with them beds of impure limestone, some of which abound in organic remains. The best exposures of these limestones are on Square or Sedgewick Lake (near the middle of its western side) where their existence and fossiliferous character was first made known by the officers of the Maine State Survey in 1862. In the following year a valuable paper descriptive of the organic remains found in this locality, was published by Mr. E. Billings in the Journal of the Portland Society of Natural History. In addition to criticalremarks upon Silurian and Devonian fossils from various parts of Maine, this paper contains figures and identifications of twenty-eight species, fifteen of which were therein described for the first time. As this work was therefore essentially Canadian, and as the only more recent explorations of the locality have been those of the Canadian survey, and as we have been able in our collections not only to recognize all the forms described by Mr. Billings but to add several additional species, including at least two more forms which are new, we think it but right that the complete list of these interesting and often typical remains should be given here.

Square Lake limestone.

Paper by E. Billings.

Fossils from Square Lake.

CATALOGUE OF FOSSILS FROM SQUARE LAKE (LAKE SEDGEWICK) AROOSTOOK COUNTY, MAINE.

ZOOPHYTA.

Zaphrentis, sp. indt.
Favosites Gothlandicus, Lamarck.

POLYZOA.

Fenestella, sp.

BRACHIOPODA.

Pholidops ovata? Hall.
Orthis discus, Hall.
" *eminens?* Hall.
" *strophomenoides*, Hall.
Streptorhynchus perplanum? Conrad.

Fossils from Square Lake.

Strophodonta punctulifera, Conrad.
Strophomena rhomboidalis, Wilckens.
" *indentata*, Conrad.
Spirifera macropleura, Conrad.
" *perlamellosa*, Hall.
" *modesta?* Hall.
" sp. indt.
Athyris Harpalyce, Billings.
" *Blancha*, Billings.
Meristella laevis, Vanuxem.
Retzia dubia, Billings.
" *Electra*, Billings.
" *formosa*, Hall. (sp.)
" *Hippolyte*, Billings.
Atrypa reticularis, L.
Rhynchonella Mainensis, Billings.
" *bialveata*, Hall.
" allied to *R. Aspasia*, B., and *R. altiplicata*, Hall.
? *Rensselæria Portlandica*, Billings.

LAMELLIBRANCHIATA.

Pterinea, sp.

GASTEROPODA.

Platyceras ventricosum, Conrad.
" *tenuiliratum*, Hall.
" *dilatatum*, Hall.
" *retrorsum*, Hall.
" *curvirostrum*, Hall.

CEPHALOPODA.

Orthoceras rigidum? Hall.
Oncoceras, sp. indt.

TRILOBITA.

Proetus Junius, Billings.
" *Macrobius?* Billings.
" n. sp.
Bronteus Pompilius, Billings.
Phacops Trajanus, Billings.
Lichas Billingsi, N. sp.
Leperditia, sp.

No other rocks are seen in immediate connection with these limestones on Sedgewick Lake, but on several of the associated lakes and on the intervening "thoroughfares" are beds which cannot be very far removed from them in age. On Long Lake, the most easterly of this chain of depressions, and which is not more than seven miles from the St. John River, the rocks are chiefly slaty, and much the same in character as on the latter stream, but on a small island near its head include also ledges of soft and rubbly dark grey sandstone, from which was obtained the pygidium of a trilobite. These sandstones are believed to mark the eastern extremity of a belt of rocks which extends all the way from Long Lake to Eagle Lake, but which is best seen upon the latter. The exposures at Eagle Lake are in a series of bluffs which form its eastern shore about a mile below the entrance of the "thoroughfare" from Square Lake, and present the following apparently ascending section :—

Long Lake

Eagle Lake section.

Brownish red shales and conglomerates. The latter are produced by the enclosure in the shales of numerous small rounded pebbles and one very large irregular mass, 10 feet by 4 feet (possibly a lenticular bed), which are themselves conglomerates or coarse grits, containing numerous particles of green, red and black jasper, as well as serpentine, mingled with the remains of shells, corals and crinoids.

Brownish-red conglomerates, similar to the above, but containing less shale, the pebbles mostly small, and with few fossils.

Hard and fine grey buff-weathering sandstone and grits, showing casts of crinoids on weathered surfaces.

Dark-grey sandstones and shales, much contorted and filled with seams of spar, the joint surfaces often somewhat plumbaginous.

Dark-grey slates, holding obscure remains of plants.

Bright red slates and dark rubbly slates.

Dark-grey, bluish-weathering slates, of the ordinary Silurian type.

All of the above beds have a north-westerly dip, and though not forming an absolutely continuous section, appear to be all members of one group. Similar beds are seen at intervals also along the Square Lake thoroughfare and again on that by which Fish River flows from Nadeau Lake near the road to Fort Kent. They are a part of the series which in the Maine reports is described and mapped as Devonian, and the occurrence in the shales of gritty pebbles containing Silurian fossils (*Favosites, Alveolites, Nematopora, Chætetes* and crinoidal stems), would seem to give some support to this conclusion, but as similar grits are interstratified with the shales and also contain similar fossils, it is quite as probable that all are contemporaneous and all Silurian. It may be added that the whole series bears a most marked resemblance to the beds of the Beccaguimic river, in Carleton county, New Brunswick, (described in Report of 1882-84) and which are undoubtedly Silurian.

Maine reports

About twenty miles to the south of the depression or series of depressions above described, and drained by the east branch of Fish River, is the approximately parallel east and west depression occupied by the Aroostook. The intervening tract is occupied by comparatively high and broken land which, however, is almost completely intersected by the south-westerly or main branch of Fish River, and which thus serves to reveal to some extent the general character of the rocks composing it. These, as seen at different points on the shores of Nadeau Lake, are somewhat various, some consisting of coarse, reddish-grey conglomerates, holding pebbles of grey and red felsite and red jasper, and having a moderately low dip (N. < 30°) while others are hard grey felsitic and dioritic rocks associated with hard greenish-grey and reddish or purplish jaspery slates with a dip N. < 80°. Aroostook depression. Nadeau Lake.

It is altogether probable that the former are of the same age as the conglomerates of Long and Eagle Lakes, and like the latter presumably Silurian, but their relations to the crystalline and silicious rocks on which they rest and from which their material has evidently been derived, would seem to indicate that we have here another older and unconformable formation. From somewhat similar facts observed elsewhere, as for instance on the river Alleguash at Churchill Lake, we are disposed to regard these latter as either Cambro-Silurian or possibly even Cambrian. It may, however, eventually turn out that they represent the very lowest portion of the Silurian system, which in southern New Brunswick presents the same silicious and volcanic character, but which has not been elsewhere observed in the more northerly portions of that province. The reference of the conglomerates to the Silurian receives some confirmation from the fact that midway between Nadeau and Portage Lake coarse-grey, gritty limestones, similar to those of Sedgewick Lake, are again met with and like them contain remains of corals, shells and crinoids. Their dip here is S. 50° E. < 60°. Following them, as the stream is ascended, are slaty rocks which are rubbly and filled with concretionary layers, recalling the beds seen at the eastern extremity of Long Lake. No other exposures are seen on this stream as far as Portage Lake. Rocks older than the Silurian. Fossiliferous limestones.

Between the head of Portage Lake and the Aroostook River the distance is ten miles. Neither on the lake nor along this portage have we had any opportunity of making extended examinations. It would appear, however, that about the former the rocks are chiefly trappean, forming a portion of an extensive belt of such rocks which is very conspicuous about the upper Alleguash lakes (Churchill and Spider lakes) and about the head-waters of the Aroostook. It includes the somewhat prominent chain of the Aroostook mountains and thence extends eastwardly to and beyond Portage Lake on Fish River. Between Trappean rocks Ashland.

this lake and the Aroostook at Ashland, the rocks are partly slates an partly conglomerates which are better seen in the valley of the firs named stream between Ashland and Presquile.

The strata to be first noticed occur in the village of Ashland. Jus opposite the hotel, in this village, is a low ridge of limestone, whic was at one time quarried for burning, but is now mostly concealed b soil. These beds were described to us as being abundantly fossil ferous and there is little doubt that, like the Square Lake rocks an like other beds to be presently noticed, they are of Lower Helderber age. Just south of and beneath them, on the road to Masardis, ar other ledges of grey buff-weathering sandstone alternating with gre rubbly shales and holding soft crumbling ochreous bands which ar filled with crinoid stems and other organic remains. Among the latte but poorly preserved, are the following :—? *Atrypa reticularis*, L. *Orthis*; a lamellibranchiate shell, most probably a *Cypricardinia Eatonia*, sp., and *Spirifera*, sp.

Fossils on Masardis road.

The course of these beds is a little south of west, and in this directio they run towards the Aroostook River, not far from which, and at distance of three-quarters of a mile from Ashland, the limestones agai crop out on the farm of Mrs. Adams. From these beds the followin fossils, of Lower Helderberg age, were collected :—

Fossils from Mrs. Adam's farm.

Stromatopora.
Favosites Gothlandicus, Lamarck.
Polypora Psyche? Billings.
Strophodonta punctulifera, Conrad.
Strophomena rhomboidalis, Wilckens.
Merista arcuata, Hall, (fine specimens.)
Murchisonia, sp.
Loxonema Fitchi, Hall.
Platyceras, sp.

Aroostook River.

These limestones are not exposed in the channel of the Aroostoo but not far from where they should appear, the right bank of the rive three-quarters of a mile above Ashland bridge, shows ledges of gre and flaggy calcareous sandstones, filled with what appear to b carbonized remains of plants. Their dip is W.<80°. The next rock seen in descending the stream occur about a mile below the bridge an are a continuation of similar beds, better exposed at the Mill on the Bi Machias. They are grey slaty sandstones, so calcareous as almost t deserve the name of limestones; associated with them are bedded gre and buff-weathering arenaceous slates, dipping N.80°W.<70°.

Plant remains.

About one mile and a half further down, the shore shows ledges of red, green and grey slates, forming a low arch, with a dip N.30°W., sinking from 45° to 30°. Similar rocks including there beds of grey, calcareous conglomerate cross the Ashland road not far from the village. To these, at a distance of a quarter of a mile, succeed hard grey sandstones, dipping E.<60°, which, with bluish weathering slates, continue to occur at intervals, as far as a point about three miles above Beaver Brook. The only fossils observed in them were crinoids, contained in soft rusty and gritty beds, much like those in Ashland. Half a mile below the last exposure of these sandstones the next rocks are found to be quite different in character, being very coarse conglomerates, filled with large and well-rounded pebbles of metamorphic rocks, including red syenite, grey quartzite, porphyry and amygdaloid, as well as green and black silicious slates and jasper. The beds are massive, and as indicated by finer layers, dip quite regularly S.80°E.<50°. These conglomerates constitute a very striking feature in the geology of northern Maine, being exposed at various points both north-west and south-east of the Aroostook River, while large boulders derived therefrom are thickly strewed over the adjacent country. On the road from Ashland to Castle Hill, and four miles from the former, where they form somewhat prominent ridges, they may be seen to be overlaid by the grey sandstones and grits, now dipping N.<20°, and forming a portion of a low fold.

Red and green slates

Coarse conglomerates.

On the Aroostook also, the next succeeding beds, about half a mile below the last exposures of the conglomerates, are sandstones, but here their dip is at a still lower angle, being only 5° or 10° in a S.S.E. direction. In the Maine geological reports both the conglomerates and sandstones are represented as being portions of long belts of such rocks crossing the state, and regarded as of Oriskany or Devonian age. Both the character of the rocks, however, and their organic remains would seem to indicate that their true position is very much lower, and that they are the probable equivalents of the Pointe aux Trembles and Tuladi rocks of the Temiscouata section, or of those of the Seigas River, described above. The sandstones possess the same vescicular or amygdaloidal aspect, are similarly marked by the occurrence of numerous small fragments of black slate, with others of serpentine, and contain, in addition to carbonized vegetable remains, shells which appear to indicate a horizon about that of the Niagara formation. Among these are the following :—

Strata described in Maine reports as Devonian, probably Silurian

Fossils from Aroostook River.

Impression of a coral, resembling *Favosites*.
Impression of a Bryozoon, probably *Callopora*.
Orthis, sp.

Streptorhynchus subplanm. ? Conrad.
Strophomena rhomboidalis, Wilckens.
Spirifera, sp., like *S. radiata*, Sowerby.
Atrypa reticularis, L.
Rhynchonella, sp.
Cornulites, like *C. Clintoni*, Hall.

Beaver Brook to Salmon Brook

On the great bend of the Aroostook below Beaver Brook, both the conglomerates and sandstones reappear at intervals for a mile or two, their low inclination (from 16° to 30°) and varying direction of dip indicating a succession of low folds. These are still more conspicuously seen in the slaty rocks which then succeed and border the river for the greater part of the distance to Salmon Brook in Washburne. These slates are mostly dark bluish grey, but often have a pale greenish cast, which is heightened by weathering. They include thin layers of grey sandstone, and in places also thin layers of dark-blue compact limestone. These are especially noticeable as presenting precisely the same peculiarity as that already noted in the case of the limestones on the Siegas in New Brunswick, viz., that of their being transversely broken into distinct and separate blocks, as if by a series of vibrations, and leave little doubt that they are a continuation of the same beds. The green and red slates are similarly an extension of those noted on the south side of Grand River, N.B. For much of the distance the folds are so broad and low as to be almost flat, but at times there is an abrupt transition from these to plications of a much steeper and more complicated character. Near the Salmon Brook the slates contain, as first noticed by Dr. Chas. T. Jackson, beds of slaty hematite, another feature in which they resemble those of Grand River, as well as those of Jacksontown, near Woodstock. It is highly probable that, with the latter, they are the representatives of the Clinton group of the New York system.

Limestones of peculiar structure.

Slaty hematite.

Intrusive syenite.

Between the mouth of Salmon Brook in Washburne and the town of Presquile, the banks of the Aroostook, which here flows south-easterly, are mostly occupied by intervales, the only exposure seen being of syenitic rock, undoubtedly intrusive. Between Presquile and the confluence of the Aroostook with the St. John, in which distance the stream does little more than double back upon itself, the exposures are also very few, except in the last four or five miles, where, as fully described in former reports, they consist of highly disturbed calcareous slates, intersected by numerous dykes of trap. On the south of Presquile, however, along the Houlton and other roads leading in that direction, beds are soon met with, which indicate that the silicious and volcanic rocks, already described, to the northward of the Aroostook

Volcanic rocks

Valley, here come again to the surface, and again break the continuity of the Silurian tract. They are best seen along the road leading through Mapleton, where, after passing a belt of bright red sandstones and conglomerates, which are believed to be of Lower Carboniferous age, and which rest unconformably upon the Silurian slates, we find these latter succeeded, four miles from Presquile, first by a series of grey sandstones, which are more or less vesicular (and which are better seen in the village of Spragueville), and then by grey ochreous rocks, which are both porphyritic and amygdaloidal. The most striking exhibition, however, of these last-named rocks is that to be seen, twelve miles from Presquile, in and around what is known as the Haystack Mountain. This singular eminence, rising abruptly, and on one side almost precipitously, from a comparatively flat country, and constituting a very conspicuous landmark, is itself essentially composed of a pale liver-grey, white-weathering felsite, which is more or less porphyritic; but around its base are heavy beds in which these felsites alternate with coarse amygdaloidal and ash-like rocks, in places carrying considerable quantities of chlorite and jasper. Not far from the mountain there are also exposures of very black and fine-grained flinty slates, but we have had no opportunity of ascertaining their relations or of further investigating this interesting country.

Lower Carboniferous.

Haystack Mtn.

Felsite.

Comparison of the Silurian System of Southern with that of Northern New Brunswick and Quebec.

In the several Reports of Progress for the years 1870-76 inclusive, details of the distribution and distinctive features of the Silurian system, as developed in the southern counties of New Brunswick, have been given by one of the present authors, in connection with Messrs. Ells and Matthew. As these features present many interesting points, both of resemblance and of contrast, with those of the region described in the earlier pages of the present report, it has been thought that a brief comparison of the two and a statement of some of the conclusions thereby suggested would not be devoid of value. It may be added that a further interest has been given to the subject by the observations of Prof. N. S. Shaler, made in 1884, on behalf of the United States Geological Survey, in and about Passamaquoddy and Cobscook Bays, and published in the form of a preliminary notice, in the American Journal of Science, July, 1886. In the following remarks we shall have occasion to refer to some of the conclusions therein arrived at.

Previous reports.

Prof. Shaler on Cobscook Bay rocks.

Among the several localities in Southern New Brunswick characterized by the occurrence of Silurian rocks, there are two in which, from the completeness of the exposures, they may be most advantageously

Typical localities.

studied, and which may hence be regarded as typical. These are the shore of Mascareen peninsula, forming a portion of the eastern side of Passamaquoddy Bay, in Charlotte county, and the southern part of Queen's county. The sequence of strata in each of these, and their parallelism, as explained in the reports referred to above, is given in the following comparative table:—

Sequence of Silurian Strata in Southern New Brunswick.

Comparative table of Silurian strata.

I.—Mascareen Peninsula. Div.		Ft.	II.—Southern Queen's County. Div.		Ft.
I.	Grey felspathic slates, about	400	I.	Grey and dark grey slates	400
II.	Grey and black banded silicious slates, with nodular layers	620	II.	Dark grey and black silicious clay slates, distinctly banded	600
III.	Grey flaggy sandstones, with some conglomerate. Shells of *Lingula*, *Modiolopsis* and *Loxonema*? with comminuted vegetable matter	350	III.	Dark grey and greenish grey (sometimes purplish) sandstones, becoming slaty above	600
IV.	Red and green slates and sandstones, with diorites and felsites	300	IV.	Ash grey and greenish grey schistose beds, dioritic and amygdaloidal	300
V.	Dark grey and reddish porphyritic felsites	300?	V.	Grey and dark grey, sometimes reddish, porphyritic felsites, with chlorite schist and breccia conglomerate. Thickness 800 feet or more.	

Since the publication of the reports upon which these tables are based, much more numerous collections of fossils from certain of the strata have been made, both in New Brunswick and Maine. As a list of those found in New Brunswick has not yet appeared in the reports of the survey it may appropriately be given here. For the Maine lists reference must be made to the preliminary Report of Prof. Shaler, cited above.

The following fossils have been obtained from Back Bay, in Charlotte county, in beds supposed to be those of Division I. The list is based upon collections made partly by Mr. T. C. Weston in 1869, and partly upon others made subsequently (1884) by L. W. and J. W. Bailey, G. F. Matthew and others.

Back Bay fossils.

List of Fossils from Back Bay, Charlotte County, N.B.

Heliolites, sp. indt.
Obolus Davidsoni? Salter.
Orthis hybrida, Sowerby.
Orthis uberis, Billings.

Orthis, sp. indt.
Streptorhynchus subplanum, Conrad.
Strophodonta indentata ? Conrad.
Strophodonta punctulifera, Conrad.
Strophomena rhomboidalis, Wilckens.
Leptaena transversalis, Dalman.
Spirifera crispa, Hisinger.
Spirifera radiata, Sowerby.
Atrypa reticularis, L.
Rhynchonella, allied to *R. cuneata*, Dalman.
Pterinea, sp. indt.
Euomphalus ? with *opercula* associated.
Proetus, sp. indt.
Encrinurus punctatus, Wahlenberg.
Dalmanites limulurus, Green.

Age of Back Bay rocks.

In Pal. Fossils, Vol. III., Part 1 (1884), Mr. Whiteaves expresses the opinion that the Back Bay rocks are possibly of about the same age as the Guelph limestones of Ontario.

Shackford's Head fossils.

The fossils collected by Prof. Shaler are chiefly from Shackford's Head and other points about Cobscook Bay, some of which, with their fossiliferous character, were described in the New Brunswick report for 1871*. From the lists given, which, however, are stated to be incomplete, the horizons represented would appear to include the Lower Helderberg group, as well as the Niagara and Clinton, while in southern New Brunswick the former would seem to be nearly, if not wholly absent. Another recent discovery of much interest in connection with the Silurian system of southern New Brunswick is the finding, by Mr. G. F. Matthew, of the remains of pteraspidian fishes, in banded shales, referred to Div. II. of the Mascareen section, near the Nerepis Hills in King's County. (Can. Rec. Science, Vol. II., No. 4, Oct. 1886., and American Journ. Science.) The fish-bearing beds are regarded by Mr. Matthew as being at least as old as the Lower Ludlow, and probably of about the same age as those holding the *Palaeaspis* of Prof. Claypole.

Discovery of pteraspidian fishes in King's county.

Equivalency of rocks in Northern and Southern N.B.

If now we compare these rocks of southern New Brunswick with those described in the northern part of the same province, and in Quebec and Maine, it will appear that neither in the Gaspé peninsula nor along the south shore of the St. Lawrence have we anything which, either in lithological features or in its contained fossils will correspond to Divisions I. and II. of the first named district, although such equivalency is perhaps to be found in Divisions II. and III. of the

*Geol. Survey of Canada, Report of Progress, 1870-71.

Anticosti group. If, however, the structure which we have described on Lake Temiscouata be the true one, the counterpart of these beds is perhaps to be found in the conglomerates and succeeding slates, more or less silicious, which occur between Black Point and Pointe aux Trembles, and of which the fossils indicate a low zone in the Silurian system. In northern Maine silicious and felspathic slates have also been described as rising from beneath the Silurian rocks on the Alleguash and Fish rivers, as well as south of Presquile, but these are much finer-grained and more nearly resemble some of the beds which, upon the Beccaguimic River in Carleton county, N.B., have been found to contain a Cambro-Silurian fauna. It is interesting also to notice that in northern Maine, as in southern New Brunswick, there are, in association with undoubted Silurian rocks, extensive beds which may be a portion of the same system, altered by contact metamorphism. The most noticeable of these are fine-grained micaceous and gneissic sandstones, with some interbedded slates, which are found on the shores of Umsaskis Lake of the Alleguash River, and which, alike in their texture, in their peculiar purplish or lilac colour, and in the abundance of what are probably imperfectly formed crystals of staurolite, bear the closest possible resemblance to strata found in various parts of New Brunswick, as on the St. Croix River in Charlotte county and in portions of York county. (See Geol. Survey Reports, 1871, 1882-4.)

Contact metamorphism.

Intrusive quartz-porphyry.

In these latter instances the alteration is evidently connected with the proximity of great masses of intrusive granite ; and so, in northern Maine, not far from the micaceous and gneissic strata are found extensive tracts of what is also evidently intrusive rock, here consisting, however, chiefly of a rather fine white-weathering quartz-porphyry, which in some places becomes granitoid, and in others epidotic and amygdaloidal. Too little, however, is known of the relations of these beds to enable us at present to speak with any confidence as to their true position.

Age of Division III.

Division III. of southern New Brunswick, as indicated by its organic remains, may be regarded as the equivalent of the Niagara formation, and consists chiefly of sandstones of grey, greenish and purplish colours. Their equivalents in the north would evidently seem to be found in the rocks of Pointe aux Trembles and the Tuladi River on Lake Temiscouata, the very similar beds of the Siegas River, New Brunswick, and those of the Aroostook Valley, in Maine, the similarity being marked both in their lithological characters and in their contained fossils. In accordance with this view, the underlying conglomerates of Burnt and Black Points, together with the shales which immediately succeed them, may not improbably be regarded as representing the Oneida, Medina and Clinton groups.

Age of Black and Burnt Point rocks.

The remaining groups of the Silurian system in southern New Brunswick are remarkable for the abundance and variety of volcanic or semi-volcanic material which they contain, such material being quite noticeable in Division IV., but reaching its maximum in Division V. A further peculiarity characterizing these higher beds is that of their low inclination as compared with the groups below them, and which appear to indicate extensive physical movements as accompanying, and perhaps determining, the igneous outflows which there originated. This latter feature is also paralleled at the north, where, if the views advanced as to the structure on Lake Temiscouata are correct, a similar want of conformity and difference of attitude exists in the two divisions of the Silurian system as there represented. But while in southern New Brunswick these movements would seem to have left the areas affected for the most part above the sea level, the higher members of the system being but slightly represented, if at all; in northern New Brunswick and in Quebec they were followed by a subsidence which, over very extensive areas, led to the origination of marine sediments, including thick beds of coral-bearing limestones,—the lower or calcareous portion of the Gaspé series—and which continued to or beyond the close of the Silurian era. It may be added, that in the red and green shales which underlie the limestones at the base of Mount Wissick, in the somewhat similar beds found about the Fish River lakes, and on the Aroostook River, in Maine, and again near the Grand River and the Beccaguimic River, in New Brunswick, we have what are probably the equivalents of Division IV. of the Mascareen and Nerepis sections; while in such rocks as the felsites and dolomites of the Haystack Mountain, in Maine, that of Moose Mountain, in Carleton county, N.B., or, still better, in the similar rocks so conspicuously developed about the Bay Chaleur, we may likewise have the equivalents of Division V.

Volcanic material in Div. IV. and V.

Unconformity in the Silurian.

The following table, by comparison with those given on page 48 M will serve to make the above relationships more intelligible:—

Supposed Sequence of Silurian Strata in Northern New Brunswick, Quebec and Maine.

Sequence of Silurian strata.

Divs. I. and II.—Grey argillaceous and silicious slates, including (locally) heavy beds of conglomerate. Fossils somewhat numerous in upper part, including shells and graptolites, indicating a low Silurian horizon.

Conglomerates and succeeding slates of Black and Burnt Points, on Lake Temiscouata; felspathic and silicious slates of Fish River and Alleguash River, Aroostook county, Me.? Conglomerates and graptolitic slates of Beccaguimic River, Carleton

Sequence of Silurian strata.

county, N.B. Supposed to be equivalent to the Medina and Clinton groups of New York, Divs. 2 and 3 of Anticosti group, or groups B and B′ of Arisaig.

Division III, A.—Grey flaggy and massive sandstones, with some conglomerate, becoming frequently greenish or purplish, and more or less amygdaloidal. Fossils rather numerous, including corals and shells, as well as worm-tracks and comminuted remains of plants.

Sandstones and conglomerates of Pointe aux Trembles, Tuladi and Squatook Rivers, Quebec; similar beds of Siegas River, New Brunswick; sandstones and conglomerates of Aroostook county, Me.; similar beds of Beccaguimic River and other parts of Carleton county, N.B.

Niagara formation, or Wenlock group.

B.—Lower sandstones, shales and limestones of the Gaspé peninsula. Similar sandstones and limestones of the head waters of the Chatte and Matane rivers, Metapedia Lake, Metis and Rimouski rivers, and lower part of Mount Wissick. Fossils numerous, marine.

Supposed to be equivalent to the Guelph formation of Ontario.

Divs. IV. and V.—Red and green shales of Cape Gaspé; red and green slates and sandstones of Mount Wissick; similar slates on Fish River (Eagle Lake) and Aroostook River, Maine; red and green slates of Grand River and Carleton county, N.B.; often including argillaceous iron ores. ? Felsites and associated trappean rocks of Campbellton and Bay Chaleur, Moose Mountain, New Brunswick, Haystack and Spider Lake, Maine.

Division VI.—Grey, often nodular or columnar limestones, abounding in fossils.

Upper limestones of Cape Gaspé; middle and upper rocks of Mount Wissick, regarded as equivalents of the lower portion of the Lower Helderberg.

Fossiliferous limestones of Square Lake and Ashland, Me.; Lower Helderberg.

Fossiliferous limestones of Carleton county, N.B.

Fossiliferous slates and sandstones of Metapedia River, Restigouche, Victoria, Madawaska and Carleton counties, N.B. Similar slates, etc., of Aroostook county, Me. Lower Helderberg?

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON THE

SURFACE GEOLOGY

OF

NORTH-EASTERN NEW BRUNSWICK

TO ACCOMPANY QUARTER-SHEET MAPS 2 N.E. AND 6 S.W.

BY

R. CHALMERS.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

Alfred R. C. Selwyn, C.M.G., LL.D., F.R.S., Etc.,

Director of the Geological and Natural History Survey of Canada.

Sir,—Herewith I beg to submit to you my report on the surface geology of the district embraced in the two quarter-sheet maps, 2 N. E., and 6 S. W., north-eastern New Brunswick, being the result of a detailed examination of it made during the season of 1886. These sheets, coloured to show the character and distribution of the surface deposits, will accompany this report.

My grateful acknowledgments are due to K. F. Burns, M.P., W. J. O'Brien, Collector of Customs and W. H. Chisholm, Superintendent of the Caraquette Railway, Bathurst; also to Chas. E. Fish and Dr. A. C. Smith, Newcastle, for information and various acts of kindness. The late G. A. Blair, Chatham, and Miss Andrews, Bathurst, likewise kindly furnished me with lists of barometric readings taken at the meteorological stations under their charge.

I have the honour to be,

Sir,

Your obedient servant,

R. CHALMERS.

Ottawa, April, 1887.

REPORT

ON THE

SURFACE GEOLOGY

OF

NORTH-EASTERN NEW BRUNSWICK,

To Accompany Quarter-sheet Maps 2 N.E. and 6 S.W.

The detailed investigations of the surface geology of New Brunswick were continued during the past season (1886) and the areas embraced in the two quarter-sheet maps, 2 N.E. and 6 S.W, adjoining the district examined during the previous season, were explored as carefully as time and circumstances would permit. These areas include the country on both sides of Miramichi Bay as far east as Shippegan and Miscou islands on the north, and Point Escuminac and Point Sapin on the south; also the chief part of the district drained by the North-West Miramichi River and its affluents, and by the Nepisiguit River. A large portion of this region is still forest-clad however, and consequently the present description, so far as it relates to topography and surface geology in the interior, is only of a general character. The chief points elucidated by the season's investigations are of much interest, both as regards the glaciation and the distribution of the surface deposits, and the results are confirmatory of previous observations made in this and contiguous areas, as will be shown in the sequel. Reference will here be made to the main facts noted :—Chief among these is the existence of pre-glacial or pre-quaternary rock debris, or gravels and sands, occupying considerable tracts, especially upon the Pre-Cambrian and Middle Carboniferous areas. The distribution of this débris and gravel is very difficult to trace, as they are usually masked by later deposits; but they appear, so far as they have been observed, to be thickest in the coastal districts and thin out irregularly towards the limits of the Carboniferous rocks to the west, re-appearing however, in the unglaciated areas of the interior, upon the Cambro-Silurian and Pre-Cambrian belts. The relations of these materials to the rocks underneath, as well as to the overlying surface deposits, have been carefully

Area explored.

Summary of main facts noted.

noted wherever exposures occurred, and a description of them will be given further on. Another subject of consideration was the enormous quantities of boulders strewn over all parts of the area under discussion, apparently derived from the more crystalline portions of the Cambro-Silurian and Pre-Cambrian rocks referred to. The absence of marine terraces in all places higher than the 150 to 175 feet contour line above sea level, indicating that the early Post-Tertiary subsidence did not exceed that limit, also afforded a question for study. Not less important perhaps, was the investigation with reference to the extensive peat bogs and sand dunes occurring here. The great development of the former near the coast, especially on Miscou and Shippegan islands, at the mouth of Tabusintac River, and at Point Cheval and Point Escuminac was noted ; and the extensive accumulations of blown sand skirting the shores, forming beaches, islands, etc., also came under review. These peat bogs and dunes are still in process of formation. The intervals and terraces along rivers, which on the North-West Miramichi and its tributaries have a considerable breadth, were likewise examined and their peculiar features investigated. Aneroid measurements of the heights were made at all accessible points, and surface contours, generally, carefully observed. The limits of the forest-covered tracts and of those portions overrun by fires, especially the great Miramichi fire of 1825, were traced out approximately and mapped. The old Indian camping grounds at Tabusintac and Derby were also visited and a few relics found. Special attention was given to the character of the soil and its relation to the underlying rock formations. Details regarding each of the above topics will be found in the following pages.

TOPOGRAPHIC FEATURES.

Chief topographic features.

The chief topographic features of the region under examination were given in report G G (Annual Report, 1885), and are comparatively simple when viewed in their general aspect. They consist of a highland region in the west, underlaid by the Pre-Cambrian and Cambro-Silurian rocks, and a level, or gently sloping plain in the east occupied by Carboniferous sediments. Minor irregularities diversify the surface of the central and eastern portions of the district however, many of which, as for example, that part of the low valley of the main South-West Miramichi River included in the map, the valley of the North-West Miramichi from Red bank to Portage River, and that of the North-West Millstream, etc., extend transversely to the main slope. The larger river valleys are all of pre-glacial origin. Where they pass through Carboniferous rocks these valleys are comparatively shallow, having been largely filled with fluviatile and marine deposits. During

the later Tertiary period, the region stood at a higher level than at present; for there is evidence that at the confluence of the North-West and South-West Miramichi rivers they flowed along channel bottoms then which are upwards of 100 feet below the existing sea level now, (see p. 14 GG Annual Report, 1885). The upper portion of the main North-West Miramichi and of its chief affluents, and also the Nepisiguit have all cut deep trenches into the older rocks, and produced some remarkable topographic features in the area drained by them. The tract of country occupied by the Pre-Cambrian here is high and rugged, the general level above the sea being not less than 1200 to 1400 feet. Mountains loom up on every hand, 1500 to 2000 feet high,* with valleys between them extending in all directions. In these lie numerous small lakes. Viewing the country from some crowning peak, it has an extremely mammillated appearance, and may be said to resemble a sea of hills. Much of it having been denuded of its forest-covering by fires, and presenting only bare, boulder-strewn acclivities and peaks, its sterile features are thus brought prominently into relief. So varied and irregular, indeed, are these that no adequate description of their countless diversities of form can be given. The original table land, if such it ever was, has been intersected in every direction by valleys of erosion. No traces of glaciation were observed, apparently all the excavating and sculpturing which fashioned these ancient hills having been effected by subaerial disintegration. In the valleys and on some of the slopes of this Pre-Cambrian area, especially along the Nepisiguit, the original forest still remains, but fires and the lumberman's axe are every year making further encroachments on it.

Evidence regarding elevation of region in later Tertiary period.

General elevation and description of Pre-Cambrian area.

Non-glaciated character

The areas occupied by Cambro-Silurian rocks are of somewhat less elevation than the Pre-Cambrian, and have by no means as rugged a surface, being rolling and the hills having long sweeping outlines. In the vicinity of the Nepisiguit, and, indeed, in the whole region between that river and the Little South-West Miramichi the general elevation of the Cambro-Silurian, especially of that portion lying between the two Pre-Cambrian belts, is 900 to 1000 feet, with occasional summits rising to 1500 feet. The south-western band of these rocks bordering the Carboniferous area is, however, much lower and less rugged, and contains many tracts of good land. (For a graphic description of this interior region, see Dr. Ells' report (Report of Progress 1879-80).

Description and height of Cambro-Silurian belts.

In the Carboniferous area the surface does not anywhere rise higher than 500 or 600 feet above the sea, and the larger portion included in the maps only from 150 to 200 feet (see 200 feet contour line). This tract has likewise been subjected to prolonged denudation. Wide,

General features and elevation of Carboniferous area.

* The elevations are all above sea-level, unless otherwise stated.

low, east-and-west valleys are characteristic features, especially in the area between the Baie des Chaleurs and Miramichi, and undoubtedly owe their origin to subaerial and glacial erosion. Most of these are traversed and drained by the rivers and streams of the district. In the areas between river valleys and also about the heads of the small streams, where the drainage is insufficient, shallow peat bogs are of common occurrence.

Rivers and Lakes.

Character and age of principal rivers.

The two principal rivers of the district, viz., the Nepisiguit and North-West Miramichi exhibit somewhat different features. The latter has numerous branches ramifying to the west and north, and drains, in proportion to its size, a much larger area than the Nepisiguit. Its wide, drift-filled valley in the lower part, and its silted up estuary (see Annual Report, 1885, p. 14 G G) afford evidence of its being the older of the two. It is probably of pre-Carboniferous date. The Little South-West, its chief affluent, and the swiftest river in northern New Brunswick, appears, from the large quantities of drift material occupying its valley, to have been at one time a larger river than the main North-West. A noticeable feature of the North-West Miramichi, probably due to peculiarities in the mode of drainage, is its wide shallow channel, especially in that part of its course traversing the eastern belt of the Cambro-Silurian and the Carboniferous rocks. The region around the head-waters of this river being mountainous, and largely denuded of forest, the snow every spring is more rapidly melted there than farther down where it passes through a forest-clad tract. Hence floods from the upper part of the river are precipitated into the lower reaches, widening the channel, and often overflowing the flats bordering it. Summer and autumn floods act similarly when they occur, as they occasionally do, the rainfall of the region about the head waters of the river being then likewise more rapidly drained off. Hence large quantities of detritus from above are deposited along the lower part of the river's course, where the country is comparatively low and flat, partially filling its channel, and causing the waters to spread and erode the banks and intervales bordering it.

Singular features of N. W. Miramichi.

These peculiarities in the North-West Miramichi seem to be the result of the disappearance of the forest in the region about its head waters. During the melting of each winter's snow, or during other floods, it thus rises above the normal height and soon runs out, so to speak, very little of the precipitation being held in the lakes and tributaries there as a reserve supply. The summer level of this river is consequently very low, considerably lower I am informed now than previous to the devastation of the forests.

In reference to the Nepisiguit, the observations of the past season appear to confirm the conclusions arrived at in report G G (Annual Report, 1885), viz., that in the lower part of its course, *i.e.*, from the Narrows downwards, its present channel is of modern date, regarded from a geological point of view, and may have been formed chiefly in the Post-Tertiary period. Nepisiguit probably of Post-Tertiary age in lower part.

The other rivers of the district exhibit no features requiring special mention, except, perhaps, Napan and Black rivers, which have valleys widely and deeply filled with marine deposits capped with alluviums. During the emergence of the land from the early Post-Tertiary subsidence, the waters of the main South-West Miramichi must have partly flowed out in this direction carrying sediment and probably boulders thither, as much of the material constituting the surface deposits here seems to have been derived from the region drained by that river. The finer material has, however, been partially remodelled since by the sea.

Classification of the Surface Deposits.

The following deposits were met with in the district included in the quarter-sheets 2 N E, and 6 S W. the series being in descending order: Classification of deposits.

M 3

Alluviums, or Recent Deposits.

Fresh-water. (a)	*Marine.* (b)
1 Decayed vegetable matter, or vegetable mould,	1 Estuarine flats,
2 Peat bogs,	2 Salt marshes,
3 Lacustrine and fluviatile marshes,	3 Sand dunes,
4 River flats (intervales)	

M 2

Stratified Sands, Gravels and Clays.

(a)	(b)
1 River terraces and kames of river valleys.	1 Saxicava sand and Leda clay
2 Stratified inland gravel, sand and clay.	

M 1

Glacial Deposits.

1 Boulder-clay or till, boulders and erratic blocks.

Pre-glacial.

1 Rock-debris *in situ* (gravel, sand, etc.)

Pre-Glacial Rock Debris, Gravels, Etc.

Pre-glacial rock debris, &c., character and mode of occurrence of.

Among the more remarkable phenomena characterizing the surface deposits of the district are beds of rotted rock *in situ*, chiefly in the form of gravel and sand. These are most abundant in the tracts bordering the Gulf shores, but are found also on the higher grounds of the interior. The materials consist of gravel, containing pebbles and boulders wholly of local rock, and occasionally beds of sand, and are unstratified except where they have not been sufficiently decomposed to obliterate the stratification of the original rock. They rest upon the surface of the unabraded rock beneath, which is generally uneven and covered with fragments of the underlying strata in process of decay. Usually these gravels do not exceed a foot or two in thickness, often less; but sometimes they are five feet or more. They are, however, for the most part overlain by stratified deposits of subærial or aqueous origin. The included pebbles and angular debris are largest and most numerous in the bottom and become smaller and more intermixed with gravel and sand towards the surface, *i.e.*, have apparently undergone greater decomposition, the further they are from the solid rock beneath. In some of the sections examined near the coast the rock surface had a sort of mammillated appearance, showing that the corroding action had penetrated more deeply in some spots than in others. No foreign boulders exist among this debris or gravel, those which occur being angular and lying longitudinally parallel to the rock strata beneath, even when embedded in loose material, thus showing that they are really portions of the original rock *in situ* not yet decomposed. Indeed, in every instance they were found to belong to the underlying rocks. The following sections will illustrate the actual position of these gravels in the series and their relation to the other deposits, especially on the coastal area.*

1. On the main post road between Chatham and Richibucto, about two miles south of Black River bridge, a section of the surface beds is exposed in a gravel pit. The series is as follows in descending order:—

Sections showing relations to other deposits.

1. Loamy material, partly composed of decayed vegetable matter with lenticular seams of whitish or greyish sands in the bottom .... 3 to 6 inches

* Sir J. W. Dawson recognized thick beds of decayed rock at Les Eboulements (Notes on the Post-Pliocene Geology of Canada, *Can. Naturalist*, 1872). Dr. G. M. Dawson has observed beds of quartzite shingle in the Bow and Belly River country which appear to be pre-glacial (Report of Progress, 1882-83-84). R. G. M'Connell also describes deposits under the name of the "South Saskatchewan gravels," which are probably of similar origin (Annual Report, 1885). Pumpelly, Hunt, Whitney, Winchell and others have directed attention to similar beds in different parts of the United States, and Darwin, Selwyn and Hartt have referred to them as occurring in Brazil. In Europe like phenomena have been observed; and in Australia Dr. Selwyn recognized the subærial decay of the rocks there, and noted the absence of lakes in non-glaciated regions.

2. Gravel and sand, unstratified, containing flat, angular pieces of rock embedded therein, apparently *in situ*.	1 ft. 6 inches
3. Rotted rock, with loose pieces of the underlying sandstone in their natural situation, but with a little gravel and sand in the interstices..........	4 to 5 feet
4. Grey sandstone showing still less decomposition and apparently passing into the usual stratified or bedded Middle Carboniferous rocks beneath.......	1 to 2 "

The height of these beds above sea level is about 80 feet.

2. Behind the village of Nelson, on the road leading to the back settlements, the following series appears in a cutting :—

1. Stratified sand and gravel..........................	12 to 15 inches
2. Boulder-clay, chiefly gravel, but with sufficient clay to cause it to bake hard on exposure................	6 to 12 "
3. Decomposed or rotted rock, chiefly gravel, unstratified, the fragments of rock 1 to 3 inches long and mostly *in situ*..................................	12 to 18 "
4. Grey sandstone (Middle Carboniferous), crumbling and decaying, *in situ*.	

Height of these beds about 100 feet above the sea.

3. At Nepisiguit bridge, near the town of Bathurst, another section of these deposits exhibits the following series (descending) :—

1. Sandy or gravelly soil, loamy in places, containing pebbles of foreign as well as of local rocks.........	3 to 6 inches
2. Stratified gravel, including pebbles and boulders. Among these are travelled boulders, 1 to 2 feet in diameter, glaciated. Bulk of material, however, belonging to local rocks..........................	12 to 15 "
3. Till, or debris of local rocks, which appears to have been shifted and acted upon by ice. It contains angular pebbles and boulders apparently transported some distance. Pieces of the Lower Carboniferous (underlying) rock, 3 to 9 inches in length, lie under and also enclosed in the lower part of the till with more or less gravel and clay in the interstices	2 to 3 feet
4. Decomposing Lower Carboniferous rocks *in situ*.	

Evidently the ice of the glacial period, in its eastward passage over the surface of the Middle Carboniferous area here, thinned out and was not of sufficient thickness or weight to displace or remove the whole of the pre-existing decayed rock material. The loose shales or pieces of rotted rock underneath what appears to be boulder-clay are one to two feet deep in places, below which they become more solid, *i.e.*, contain less gravel and sand in the interstices, until they gradually change into the usual Carboniferous rock of the district.

M I. Glacial Deposits.

Boulder-Clay or Till.

Boulder-clay.

Boulder-clay is abundant in river valleys and on slopes in the interior of this district, but is seldom met with near the coast. The North-West Miramichi valley, from where the Intercolonial Railway crosses it, up as far as Portage River and probably further, is lined almost continuously on both sides with till, and it was also seen on the slopes of the minor valleys in numerous localities. Apart from its occurrence in these, however, it does not anywhere form an unbroken sheet, usually appearing in lenticular masses. In a number of places it rests upon pro-glacial rock-debris, as shown in the foregoing sections, and is almost invariably overlain by stratified deposits. It is evident also that till in considerable quantities was thrown into the river valleys and depressions during or at the close of the ice age, partly filling them and producing changes in the drainage. This partial blocking up of the water courses held up the waters of even the larger rivers in many places, especially those of the North-West Miramichi and its affluents, to a height of 80 to 100 feet above their present level. In the vicinity of Redbank a drift-dam of this kind existed in the Post-Tertiary period, causing the formation of terraces which will be described on a following page.

Whence derived.

In all cases, the till, wherever observed, seems to be largely derived from pre-existing rotted rock belonging chiefly to the underlying formations in each particular locality, but somewhat changed in mechanical consistency and appearance by glacial action. In certain places upon the Carboniferous area this change was seen to be only partially effected, and the flat pebbles and pieces of sandstone or slabs were sometimes only partly turned over or disturbed, while the intermixed clay had, in its bluish-grey, unoxidized aspect, every resemblance to boulder-clay.

Localities where observed

A few of the more noteworthy localities where till was observed may here be specified.

On Miscou Island, on the north-east side of Miscou harbour, and on the east side of Shippegan Island till occurs. It is overlain in both places by Leda clay and Saxicava sand. If the till here is due to land ice, the land has probably been as high, if not higher, than at present when it was laid down. A slight subsidence would submerge these islands, scarcely any part of them at present rising more than 25 to 30 feet above sea level. This till is constituted chiefly of boulders and debris of local rocks.

Hospital and Sheldrake islands, in Miramichi estuary, are largely covered with till.

A bed of till occurs at the mouth of Black River, also another on the west side of the mouth of Bay du Vin River. These contain glaciated boulders.

On the road leading from Upper Chatham to Napan River, and on the main Chatham and Richibucto road just south of Black River bridge, also on the road going through the back settlements from Nelson to Barnaby River station, till was seen in several places with glaciated boulders embedded in its upper part. Some of these boulders seem to have been striated while in their present position by ice which moved over them from west to east. They lie longitudinally in this direction with the upper glaciated side sloping gently to the west as in Fig. 1. Pre-glacial debris was observed to underlie them in two of these places.* Boulders striated while held in upper portion of till.

FIG. 1. SECTION SHOWING POSITION OF STRIATED BOULDERS IN DRIFT.

Till is found in the South-West Miramichi valley in numerous places within the limits of the map. Heavy banks, chiefly of till, occur near Derby Junction and at the confluence of the South-West and North-West rivers, rising above the general level of the valley, (referred to on page 28 G G, Annual Report, 1885).

At the mouth of North-West Millstream, till, partly filling the valley of that tributary, was seen resting on glaciated rock surfaces (see List of Striæ No. 7).

Till was observed in several places along the road leading up the south side of the Little South-West Miramichi; and just above Redbank to the east of the main North-West a bed of till, abundantly intermixed with boulders, was seen.

In reference to the glaciated boulders embedded in the upper part of the till or pre-existing rock debris, referred to above, the question arises were their upper surfaces really striated while they were held in their present position by the enveloping material (boulder-clay, gravel, etc.) as the ice passed over the district. The parallelism of the striæ upon them with those on the rock surface of the district in which they occur, as also the attitude of the boulders themselves with respect to the abrading agent, tends to support this view, rendering it probable that the phenomena are similar to those described by Mr. Hugh Miller as observed in Scotland. There is abundant evidence in the presence of Remarks on striated boulders.

* Phenomena of this kind were first observed in Canada by Sir J. W. Dawson, see The Post-Pliocene Geology of Canada, *Canadian Naturalist*, 1872.

striæ on rocks *in situ* and till and other transported boulders from the interior that ice passed over the country here from west to east; but it would seem that even when the glaciers had attained their maximum thickness they must have thinned out on the particular district where these boulders were thus left, and perhaps disappeared altogether before reaching the present coast line, except in the valleys. Pre-glacial debris of subaerial origin occurs in sheets under them in most places where sections are exposed, affording proof that the ice cannot have been thick or of great weight. It seems reasonable to infer, therefore, that the ice moved over the surface of the decayed rock material, eroding and displacing only its upper part, striating the rocks where they were nearest the surface or most exposed, and also the upper surface of these boulders at the same time.

Boulders and Erratic Blocks.

Boulders and erratics whence derived.

Boulders, derived from the Cambro-Silurian and Pre-Cambrian rocks of the interior, consisting chiefly of granite, gneiss, felsite, trap, etc., from five feet in diameter downwards, are found profusely scattered over the surface of the whole Middle Carboniferous area and also embedded in the deposits. Associated therewith, and in certain places largely predominating in numbers, occur others derived from the underlying rocks. Upon the surface of the Pre-Carboniferous rocks of the interior, boulders are likewise strewn in immense profusion, and bear evidence, so far as observations have extended, of having, in some places, been transported limited distances from the parent rocks to the west.

How transported.

Near the coast, especially below the 200 feet contour line, the present distribution of boulders seems to have been effected by floating and shore ice, etc., as well as by glaciers. A greater number of those properly called erratics are seen upon the surface here, and apparently they have been subjected to greater wear, being, as a rule, more rounded and with the striæ in most instances defaced. Planed sides are still however, characteristic features of these. Sparingly interspersed among them are a few which seem not to belong to this district, and the parent rock of which is unknown. These are always found on or near the present shores.

Greater abundance on north side of Miramichi estuary.

Boulders of crystalline rocks seem to be more abundant on the southern than on the northern side of the Miramichi estuary. The cause of this is difficult to explain, but it is probably due, in part at least, to the fact that during the Post-Tertiary submergence, river and coast ice carrying boulders would be more likely to be driven against the shores of the southern side of Miramichi Bay by the prevailing north-east and north-west winds than in any other direction, and thus deposit them.

Along the shore to the east of Escuminac Point, granite boulders three to five feet in diameter were seen on the top of the peat bog and sand beaches there. They appear to have been recently pushed up by the impact of coast ice, or, perhaps, thrown up by the waves during heavy storms. Boulders on top of peat.

Glacial Striæ.

The following striæ were observed during the past summer in the areas mapped. The courses are referred to the true meridian and the elevations to sea level. List of striæ.

No.	LOCALITIES.	COURSES.	GENERAL SLOPE OF SURFACE.	APPROXIMATE HEIGHT.
	GASPÉ PENINSULA, QUE.			
1	On a ridge at Newport, half a mile from the shore, occur glaciated rocks, but no distinct striæ. Stoss-side to the N.W.	S.E.	S.E.	165
2	Along main road east of bye-road leading to Point Maquereau Light House. Striæ. (These are on the eastern slope of a ridge running out to form Point Maquereau).	S. 85° E.	S.E.	250
	GLOUCESTER COUNTY, N.B.			
3	At E. Smith's, Middle River settlement. Striæ	N. 46° E.	E.	250
	NORTHUMBERLAND COUNTY, N.B.			
4	Behind Nelson village, on second concession lots. Striæ	S. 83° E.	E.	150
5	Behind Upper Chatham, about half way between the Miramichi and Napan rivers. Striæ. (These correspond with the striæ noted at Beaver Brook station, Intercolonial Railway, and at Rogersville station; also with those seen in the valley of the South-West Miramichi at Indiantown (see report G G, p. 22, Annual Report, 1885, Striæ Nos. 64 and 66).	S. 83° E.	E.	125
6	At North-West Millstream, near bridge on road along main river. Striæ, covered with a thick bed of till. (These striæ agree in direction with others at the head of this stream, (Nos. 60 and 61, report G G just cited,) and show that a small local glacier moved down the North-West Millstream valley, debouching into the estuary of the main North-West).	S. 22° W.	S.	25

General Conclusions respecting Glaciation, Boulder Distribution, Etc.

The conclusions deducible from the foregoing facts may be briefly stated as follows:—

General glaciation of district.

1. The ice of the glacial period moved from the west down the main slope of the district towards the Gulf of St. Lawrence, carrying large quantities of debris from the Cambro-Silurian and Pre-Cambrian rocks of the interior and strewing it over the whole surface, as pointed out in report GG (Annual Report, 1885). The glacier or glaciers were guided in their movements by the more prominent topographical features and especially by the river valleys, but thinned out or finally disappeared before reaching the present coast line, no evidence being afforded that they debouched into the sea anywhere, except, perhaps, in estuaries. And the undisturbed pre-glacial debris met with on the low coastal tracts shows either that the ice did not reach these, except in a very thin sheet passing very lightly over them, or that these tracts were submerged during the greatest extension of the ice. The boulder-clay overlying the pre-glacial debris and the striated boulders over which the ice has apparently moved, may also be cited as proofs of its diminished power and weight when moving over this particular district.

Secondary systems of glaciers.

2. A minor or secondary system of local glaciers followed the smaller valleys at a later stage, as indicated by the striæ and till found along the North-West Millstream (see List of Striæ, No. 6). The glacier producing these seems to have flowed into the open estuary of the North-West Miramichi. To render this possible it is evident that the land must have then stood at a somewhat lower level than at present, and the estuary referred to would consequently be wider. Glaciers of this kind probably belonged to the close of the glacial period and may have been contemporaneous with the deposition of the Leda clay.

Boulder distribution.

3. The distribution of boulders near the coast, especially below the 175 feet contour line, is the result of two causes which may thus be stated:—First, these boulders, or the majority of them, were carried down to the coastal area, more especially along the valleys, by glaciers and river ice during or at the close of the ice age. On the submergence of this coastal tract, coast and floating ice acted upon these and the till, the sea washing away more or less of the finer and lighter materials, leaving the boulders exposed. These were then rolled about or carried hither and thither by pan or shore ice. Erratics from foreign parts may occasionally have been landed on these shores by the same agencies. Other causes no doubt supervened, but these will serve to explain the occurrence and anomalous distribution of so many boulders from the interior on the surface near the coast.

M 2. STRATIFIED SANDS, GRAVELS AND CLAYS.

Stratified Inland Gravel, Sand and Clay (fresh-water).

General description of inland stratified deposits.

Deposits of this kind are of considerable thickness above the 200 feet contour line, more especially upon the Lower and Middle Carboniferous and Cambro-Silurian rocks. Those overlying the former constitute an almost unbroken sheet, the general characteristics and composition of which have been given in previous reports. The whole series covering the surface in the district is, in descending order, essentially as follows:

1. A thin, somewhat irregular layer of loam, or more generally decayed vegetable matter, together with more or less material formed from subaerial erosion. Underneath this, or constituting a portion of the same stratum, especially upon the surface of the Middle Carboniferous area, occur lenticular seams of fine-grained grey or white sands. The peculiar character and colour of these sands are probably due to the deoxidation of the iron in them through the chemical action of the rain-water and the decayed vegetable matter overlying them.* Cultivation, by mixing these sands with the soil or subsoil, causes them to disappear. Land shells are sometimes found in the layer of vegetable matter. A fuller description of this deposit will be given in the sequel, under the head of *Vegetable Mould.*

2. Stratified sand, gravel and clay of varied thickness, the clay usually forming the lowest member and often in lenticular sheets. The pebbles in the gravel are almost always of local rock, although along river valleys they have been transported considerable distances. The colour of these sands and gravels, and of the upper portion of the clay also, is generally of a brownish or yellowish tint, due to the oxidation and hydration of the original materials. The lower limit of the weathered zone is often sharply defined in the clay beds.

3. Boulder-clay or till in patches on hillsides and in valleys, the distribution being irregular and the thickness variable. It includes travelled boulders from the west and south-west.

4. Pre-glacial debris, or gravels and sands. These occur irregularly upon the higher grounds of the interior, thinning out to mere loose pebbly beds, as observed in the tract about the head-waters of the North-West Miramichi.

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* "The organic matter carried down by the rain-water reduces the iron salt from a peroxide to a protoxide, which the free carbonic acid present converts into a carbonate: and this salt being soluble is removed by the same surface waters, leaving the upper part of the sand or gravel colourless or often white. Or, it may sometimes be that the humic acid in the soil removes the iron as a soluble humate." "When the humous acids can freely attack the hydrated peroxide of iron they remove it in solution and the decomposed rock or soil is thereby bleached. This is common where pine trees grow on ferruginous sand."—(Prestwich's Geology, Vol. 1, p. 143.) (Geikie's Text-book of Geology, p. 438.) (For further information on the geological action of the humus acids upon sands, gravels, etc., see paper by A. A. Julien, Proc. Am. Association for the Advancement of Science, 1879, pp. 339-350.)

How derived. The origin of these inland fresh-water deposits was briefly discussed in preceding reports. They appear to be derived in the first place from the decomposed materials of the underlying or subjacent rocks. Afterwards, glacial erosion, river and atmospheric action, combined with that of an organic nature, have produced such changes in them, more especially in the uppermost portion, as to partially stratify them, and give them their present character and composition.

River Terraces and Kames of River Valleys.

River terraces. River terraces of varied width are developed along the North-West Miramichi and Nepisiguit rivers, and, indeed, skirt all the streams of any size in the district. Their general features and relation to the rivers which they accompany have been discussed in former reports. Along the streams traversing the low flat Carboniferous area, none worthy of note were observed; but as we pass up the river valleys into the older series of rocks they become more noticeable. The localities and elevations of a few of the principal ones met with along the North-West Miramichi and Nepisiguit rivers may here be mentioned. The heights given have reference to the rivers at the nearest point.

Commencing with the Nepisiguit we find:—

Heights and localities where they occur. 1. At Middle Landing Narrows a terrace on the north bank 45 to 50 feet high, or 95 feet above sea level.

2. At Grand Falls a wide one occurs also on the north side 60 to 70 feet higher than the river above the falls, or about 315 feet above the sea. It is composed of water-worn gravel and sand with a covering of loam.

3. Just above the mouth of Nine Mile Brook a terrace lies on the north bank 50 to 65 feet high. It has probably been formed by a damming of the river at the Narrows five miles below, the intervening valley having then been a post-glacial lake into which the gravels, etc., composing the terrace were thrown.

4. Near Taylor's Brook there is a long terrace, or high narrow intervale on the north side of the river 6 to 10 feet above it.

Other terraces occur at numerous places, especially wherever the banks jut out opposite re-entrant angles or bends of the river, but most of them are narrow and irregular. Viewing them correlatively, however, they indicate that the Nepisiguit flowed 50 to 75 feet above its present bed in early post-glacial times.

The North-West Miramichi, and more especially its tributary the Little South-West, exhibits a number of beautiful terraces, some of which may here be briefly described.

5. On the south side of the main North-West, in the triangular tract opposite the mouths of Portage and Tomogonops rivers, wide terraces border the valley above the 200 feet contour line. Their height above the river is 50 feet and upwards. The materials are, however, all detrital. A capping of loam upon them forms good soil.

6. High terraces, probably of marine or estuarine formation, skirt the Little South-West as far up as the head of the settlement, 12 miles from its mouth. At the latter point the river bed is 150 to 175 feet above sea level, and many of the terraces are 50 to 75 feet higher. Further up they become less conspicuous, but are, nevertheless, above the usual height of the terraces found along other rivers in northern New Brunswick. They are all composed of very coarse, well-worn material, the result, no doubt, of erosion from the rapid flow of this river, the descent in the lower part of its course alone being not less than 10 feet per mile, further up being much greater.

A remarkable illustration of the post-glacial erosion effected by rivers and accompanied by the formation of terraces may be seen at the Square Forks of the Big Sevogle. The two main branches of this river here unite in a rocky gorge about 30 feet deep, which is almost in a straight line. At right angles to this the river runs off below through another rocky gorge somewhat as shown in the diagram (Fig. 2.)

Remarkable erosion and terraces at Square Forks.

FIG. 2. PLAN SHOWING PORTIONS OF ROCK GORGES AT CONFLUENCE OF THE TWO BRANCHES OF BIG SEVOGLE RIVER.

The two branches of the Sevogle have either met at a different point and had a different pre-glacial channel from their confluence downward, or existed as separate streams. From the point B in Fig. 2 down to the present confluence of the river with the North-West there is a wide, terraced valley (see map) strewn with water-worn gravel, which may have been its former course. A damming of this pre-glacial valley at B by drift during the ice age would probably cause the excavation of the gorge below the Forks.

Kames.

River-valley kames are but poorly developed in this region. Small ones were noted in several places however, and a marked one at the confluence of the Little South-West and main river. It appears to be the residual portion of a terrace eroded on both sides by these two rivers.

Leda Clay and Saxicava Sand (*marine*).

Leda clay and Saxicava sand, mode of occurrence of.

The Leda clay is rather poorly represented in the district under consideration, the detrital material resulting from the erosion of the Carboniferous sandstones being chiefly in the form of sand and gravel. In consequence of this, marine fossils are rarely found in the surface deposits here. The Saxicava sand is very widely distributed and of considerable thickness in the areas skirting the coasts and river estuaries. From the elevation of the terraces composed of it (marine terraces) in the Miramichi valley the extent of the earliest Post-Tertiary subsidence can be approximately estimated. A few of the more noteworthy of these may be described. The elevations are in all cases above sea-level :—

Terraces occur on both sides of the mouth of Little South-West Miramichi River at a height of 85 feet above sea level. They cover an area of several square miles, and are composed chiefly of Saxicava sand. No fossils.

At the confluence of the Big Sevogle and main North-West River a terrace 118 feet high was observed. It appears to be entirely formed of sand and gravel.

One to two miles up Big Sevogle River another was seen on the south side, 160 to 170 feet high, which is also composed of sand and gravel and without fossils.

Opposite the mouth of Portage River a terrace skirts the main North-West on the south side; height 150 feet.

On the road leading from Chatham to Richibucto, near upper Bay du Vin P O., terraces appear at heights of 120 and 140 feet.

A number of others were noted which it seems unnecessary here to enumerate. Co-ordinating all the facts relating to the marine terraces they show a Post-Tertiary subsidence of 165 to 175 feet in this district.

Sections showing character of materials.

To illustrate still further the composition of the terraces about the mouths of rivers, and in estuaries, as well as the general character of the deposits below the 175 to 200 feet contour line, the following sections will here be given. One examined behind Nelson village is described under the head of PRE-GLACIAL GRAVELS, ETC. Another exposed at Tracadie River is as follows, in descending order :—

1. Gravel and sand, with a few pebbles of local rocks. When these are flat and uniform they lie with their longest axes in a horizontal position	Thickness....	15 to 18 inches.
2. Grey sandy clay....................................		1 to 3 "
3. Sand and clay in irregular, alternating bands; clay seams 1 to 6 inches thick. Whole thickness........		1 to 2 feet.
4. Clay and sand, clay predominating; seams regular...		2 to 3 "
5. Sandy band, with a few thin strata of clay. Total thickness not known. Exposed in bottom of pit.........		3 "

The clay in this section is of a reddish-grey colour, and in all cases sandy, *i.e.*, nearly a loam. Both sand and clay are invariably free from pebbles. From their situation with respect to the Tracadie River these deposits are undoubtedly estuarine, although deriving the materials largely from the river. No fossils were found in them.

Near Caraquette the succession was also found to be as follows in descending order:—

1. Gravel, coarse and angular, and packed with sandstone pebbles and small boulders, also mostly angular, and lying with their longest axes in a horizontal position, the whole irregularly stratified and resembling rotted rock *in situ*. Thickness variable....................	1 to 3 or 4 feet.
2. Sand, fine and without pebbles or gravel and comparatively loose. Thickness likewise variable	1 to 3 "
3. Clay, sand and gravel, forming a hard-pan, containing fragments of the underlying rock but little removed from their original position. Thickness variable.	
4. Rubbly, broken up, decomposing rock.	

General succession of marine deposits.

The succession of these deposits as observed in a great number of sections below the 200 feet contour line is closely similar to the above, and may be generally stated as follows, in descending order: (1) Gravel mixed with sand, overlain in uncleared and uncultivated ground by vegetable mould; (2) sand of varied consistency with clayey, or mixed sandy and clayey strata; (3) clay, with sandy seams, and (4) rotted rock *in situ*, or boulder-clay. On the slopes near the coast between the mouths of rivers, where little or no detrital material from these was deposited, the series consists of (1) loam, or decayed vegetable matter, under which are sand, gravel and occasionally clay; (2) boulder clay, but this member usually absent, and (3) pre-glacial debris, or gravel resting on decomposing Middle Carboniferous sandstones. As already stated, very little pure clay occurs in the stratified portion of these beds, owing no doubt to the arenaceous character of the rocks from which they are derived.

As a rule the thickness of these deposits does not exceed five to ten feet, often less, and the surface is always even. The stratified sands, gravels and clay have been pretty fully described in preceding reports.

M 3. Fresh-water Alluviums.

River-flats, or Intervales.

Intervales.

Along the main North-West Miramichi River and its affluent the Little South-West flats of considerable extent occur and form fine tracts of farming land. Between Redbank and Portage River large portions of these are cleared and cultivated, yielding hay in abundance. Nearly all the adjacent terraces are, however, still forest-clad.

The intervales along the Nepisiguit and other rivers of the district are narrow and of little value in an agricultural point of view. No clearings of any consequence have been made upon them.

In regard to the mode of origin and character of these intervales it may be remarked that the detailed descriptions of similar deposits given in preceding reports apply equally well to those observed in this district, and, therefore, it is unnecessary to dwell further on them.

Lacustrine and Fluviatile Marshes.

Fresh-water marshes.

Many of the small lakes of the interior are bordered by marshy tracts consisting of boggy or peaty matter, but of such limited width that they cannot be shown on the maps. Similar marshy selvages skirt the rivers in places where the flow is sluggish and permits the deposition of the finer particles of matter held in suspension by the waters. These marshes are usually covered with a dense growth of ericaceous plants, rushes, carices, marsh grasses, etc., and form retreats for the aquatic fur-bearing animals.

Peat Bogs.

Peat bogs, where formed.

Formations of this kind are extensively developed near the coast of the Gulf of St. Lawrence, especially on Miscou and Shippegan islands and near the mouth of Tabusintac River; also at Point Cheval and Point Escuminac. In these localities they seem to owe their growth to the peculiar climatic conditions of the region bordering the Gulf. The proximity of the ocean modifies the extreme summer heat prevailing inland, rendering the air moister and more favourable to the continued existence of mosses and other plants peculiar to these deposits. In the interior there are also numerous peat bogs upon the Lower and Middle Carboniferous areas, but they are generally thin and of smaller extent. Usually the latter are found to occupy shallow lake basins which are bordered, and occasionally wholly covered, with a scrubby growth of hacmatac and black spruce. A remarkable feature of the bogs near the coast is the great number of small ponds dotting their surfaces. These ponds have perpendicular sides of peat, and vary

Favorable conditions for their growth.

in size from a few square yards to a quarter of an acre or more. Their mode of origin is not apparent, but it is probably due to the continuous growth of mosses, etc., around little pools which occupied a former surface, the pools preventing the growth of mosses underneath them, while around them the height continued to increase year after year. For the most part these peat bogs are treeless, but are covered with plants belonging chiefly to the following species,—rose-bay, Labrador tea, two species of vaccinium, the huckle-berry, leather-leaf, andromeda, and along the shores overhanging the drier banks, the crowberry, etc. Brief descriptions of the largest of these bogs will now be given. Ponds in peat bogs, how originating. Descriptions and localities.

1. The principal peat bog in the district occurs on Miscou Island and covers fully half of its entire area. It occupies a shallow basin in the Middle Carboniferous rocks here, portions of the rim of which, as well as of the sand and peat, are being eroded by the sea. The surface of the bog is 15 to 20 feet above high tide level in the centre, while the bottom, which is full of the roots of shrubs and small trees *in situ*, seems to be below that of the lowest tides and wherever visible appears to rest on gravel and sand. The bog, as already mentioned, is dotted all over with ponds, which form favourite resting places for the wild geese and brant in their passage over the region every spring and fall. Cranberries abound on it. Miscou bog.

2. A peat bog about three miles long and one and a half wide was seen on the eastern side of Shippegan Island, which also rests on a hard-pan of gravel and clay. The surface is 10 to 15 feet above the sea and is likewise destitute of trees. Numerous ponds were also observed on it. In the bank the peat is 10 feet thick, the bottom descending below high tide level. Shippegan.

3. The neck of land between St. Simon inlet and Pokemouche harbour (see map) is formed of peat. Similarly to the two beds just described it is considerably higher in the central part than at the margin, but nowhere is more than 10 to 15 feet above high tide level. A part of this bog is on sheet 3 S E. Immense quantities of cranberries grow upon it. St. Simon.

4. South of Tracadie River, near Point Barreau, (see map) a peat bog borders a lake, both being surrounded by a tamarac swamp. Tracadie.

5. An extensive bog occurs on the west side of Tabusintac River; length about three miles, width two miles. Its general features are the same as those described. It is also a favourite resort for wild geese, brant, etc., every spring and autumn. Tabusintac.

6. On the east side of Point Cheval a bog was also seen which thins out on the northern margin over an old sand beach. The following section of the beds, in descending series, may be instructive:— Point Cheval.

1. Peat, dark brown in colour, containing a few roots of small trees and shrubs and abundant remains of mosses, 5 to 7 feet.
2. Dark, almost black peat, filled with stems, roots and rootlets of small birch, cedar and hacmatac trees, and heath plants. Numerous stumps of trees *in situ* occur in the bottom of the peat, and the roots penetrate, or more generally spread out over, the underlying sand. Some of these stumps are a foot in diameter............ 2 to 3 "
3. Pure, fine-grained sand, rusty and dark in upper part, into which the roots referred to sometimes penetrate a few inches. Apparently continuous with and forming part of present beach, but must be older, as it descends below sea level in places. A sharp line of demarkation between this and last member of the series. Drift-wood and sticks three to six inches in diameter appear to have been strewn over the old beach before it became covered with peat.

The surface of this bog is 10 to 15 feet above high tide level, and the bottom of the central part, so far as could be observed, sinks below the lowest ebb tides.

Point Escuminac.

7. Another large and interesting peat deposit was found at Point Escuminac (see map), referred to in Dr. Ells' report (Report of Progress, 1879-80). It is highest in the middle and likewise dotted over with numerous small ponds. From the examination made around its margin it seems to occupy a basin also, the central part of which is below high tide level. This gives it a thickness of 20 feet or upwards. Mr. Philips, light-house keeper, Point Escuminac, informed me that he found it 24 feet deep in one place. Like those already described it is almost treeless, but covered with heath plants. A section of the peat and underlying beds, taken near the Light-House, is as follows, the series being descending :—

1. Peat .... 7 to 8 feet.
2. Sand, coarse and gravelly, chiefly derived from the underlying gravel, but with more or less beach sand and foreign pebbles; the whole partially stratified......... 6 to 9 inches.
3. Gravel *in situ*, derived wholly from underlying sandstones or shales. Thickness variable.
4. Grey, Middle Carboniferous sandstones or shales.

Burnt log in peat.

Among the numerous stumps, trunks of trees and sticks in the bottom layers of the peat, or between divisions 1 and 2, a log partially burnt was observed. It is part of the trunk of a spruce tree, and has been split and shattered before it was thrown up here by the sea. About seven feet of it project out of the bottom of the peat. Three spots on one side were charred and hollowed out slightly by fire. The stumps and roots in the peat bottom around it are *in situ*.

This burnt stick is similar to many other shattered ones lying upon the existing beaches and seems to have reached its present site before the peat began to grow. Its exposure now is caused by the wearing away of the edge of the peat by the sea. Whether it is any proof of the occupancy of these shores by human beings before the growth of the peat beds, remains to be considered.

Peat beds affording proof of slight subsidence of region since commencement of their growth.

A study of all the phenomena connected with these peat beds leads to the conclusion that a slight subsidence must have taken place in this district since the commencement of their growth. The bottom of these deposits seems to be at least 10 to 15 feet below high tide level in some places, and from their proximity to the coast the basins occupied by them, if emptied of peat, would be inundated, were the relative levels of the sea and land the same when the peat began to grow as now. Hence this coast area must have been 10 to 15 feet higher, if not more, with respect to the sea then. Moreover, the fact that the bottom of these peat bogs, wherever exposed, is invariably found to contain stumps of trees *in situ* of species now growing in swampy tracts near the coast, at a height of 10 to 25 feet above sea level, corroborates the same view. On the other hand the sand beaches now covered by peat around the borders of the basins enclosing it, upon which logs, sticks, stumps, etc., have apparently been strewn by the tides before the peat grew on them, indicate that the change of level cannot have been much greater than that stated above.*

These bogs appear to be still increasing in height and breadth. The sea has, however, broken through the barriers of sand and earth which enclosed the peat basins originally, exposing their margins in certain places to its erosive action. Elsewhere they are protected by sand banks recently formed. Their economic value will be referred to further on.

Vegetable Mould, or Decayed Vegetable Matter.

Vegetable mould, how formed.

Upon the surface of the forest-clad areas and also on newly-cleared lands, a layer of material occurs often two inches or more in thickness, consisting largely of dead leaves, rotten wood, remains of herbaceous plants, etc., the lower portion of which, at least, is decomposed into humus. This was referred to on a previous page. As the soil undergoes

* There are evidences of one upward and two downward movements of the land in northern New Brunswick during the Post-Tertiary period. First, a subsidence which apparently commenced in the glacial period, the maximum of which was reached about its close or soon afterwards. The land then stood about 20+ feet below its present level relatively to the sea. The lower Leda clay appears to have been laid down at this stage. An upward movement followed, during which the upper portion of the Leda clay and the Saxicava sands were deposited, this movement continuing till the land had again risen 10 to 25 feet, or perhaps more, above its existing level with respect to the sea. The peat and marl beds were then formed, and a second slow subsidence began which has probably been in progress until recently.

cultivation, this matter becomes disseminated through it and disappears to a large extent. The fertility of newly-cleared lands, especially uplands, depends almost wholly on its presence.* These often yield crops for three years in succession without manure of any kind; but on undergoing cultivation by the plough they deteriorate and without the application of fertilizers, become, in a short time, comparatively valueless. These remarks have reference more particularly to tracts which are underlain by sand and gravel, as wherever clay beds or alluviums occur, the original fertility of the soil is much longer retained. This decayed vegetable matter seems to be more abundant in the soils of river-flats, owing to the quantities carried down by the rivers and deposited thereon from time to time as they were in process of formation. Accordingly these soils contain a considerable proportion of humus. In the interior of the district under consideration most of the hills and mountains are devoid of any organic matter in the scanty soil covering them, and often exhibit only bare rocks or shingly slopes which support a thin dwarfed growth of trees.

Causing fertility.

M 3. Marine Alluviums.

Sand Dunes.

Sand dunes, why abundant in the district.

Sand dunes are of unusual extent in this district, considering that they are merely marginal deposits. This is no doubt due to the fact that the sandstones of the Middle Carboniferous area, along the coast of which the dunes occur, have, in the process of disintegration, supplied greater quantities of arenaceous material than other rocks. From the immense beds of sand forming islands and beaches, in the Miramichi Bay, it is evident the denudation of the estuarine borders and coast has been enormous. The Miramichi River appears to have been the chief instrument in effecting this, but every stream flowing into this part of the Gulf of St. Lawrence has, no doubt, carried down greater or less quantities of sandy detritus.

Localities where dunes occur.

The character of these sand dunes was described in preceding reports. It will be sufficient therefore to briefly mention the localities of such as are known to occur in the district.

* The existence of this superficial layer has hitherto been overlooked; but in the study of the surface deposits of this district it became evident, from its thickness in many places and its relation to the seams of whitish or greyish sands underneath or associated therewith, that it was necessary to recognize it as a member of the series. In the natural forest-clad condition of the country it forms an almost universal layer, continuous with the peat beds, which indeed may be considered as a thickening of this vegetable layer in particular localities by the additional growth of mosses, etc. For the present therefore it is classed provisionally with the fresh-water alluviums.

At the north point of Miscou Island, and extending half its length on the north-west side, a wide beach occurs, consisting of ridges parallel to the shore line, the surface being five to eight feet above ordinary high tide level (see map). The inner, or first-formed ridges, are now clothed with trees (white spruce, white birch, etc.) Spruces nine inches to a foot in diameter and 20 to 30 feet high are common, becoming smaller and more scattered towards the more recently formed portion of the beach. The ridges are all about the same height, no change of level being indicated during their formation. Walrus bones occur in the oldest of these, although the living animal is not seen in adjacent waters now.*

Dunes skirt the whole eastern coast of Miscou Island, almost closing its harbour on that side, and stretching along the north-east part of Shippegan Island nearly to Pigeon Hill.

At the entrance to Shippegan harbour (east side) sand dunes extend along the shore, and thence nearly to Barreau Point (see map), enclosing Pokemouche and Tracadie lagoons.

All the islands in Miramichi Bay, except Hospital, Sheldrake and Vin are formed of sand. They have each a nucleus of dry gravel or rock *in situ* similar to that of the adjacent mainland, however, around which the sands have collected. Ridges and mounds formed by the winds and waves are characteristic features of these dunes. Their area seems to be increasing, and extensive shoals surround them. Most of these dunes are clothed with a dwarfed growth of trees or shrubbery in the central of nucleal part.

Nuclei of gravel or rock in some dunes.

Salt Marshes.

Salt marshes occur in small patches at Tracadie lagoon, also at Tabusintac, Neguac, etc. The only ones large enough to map were seen on the western side of Point Cheval and at the mouth of Black River, also on the inner side of Vin Island (see map). On all these hay in considerable quantities is annually cut. At the mouth of Dennison's Brook, and inside of Huckleberry lagoon (east side), as well as in other localities, small marshes were also noted. For previous descriptions of salt marshes see reports of 1885 and 1886.

Salt marshes, where found.

* Settlements are said to have been founded here in the 17th century by the French for the purpose of capturing the walrus or sea-cow. Such an exterminating war was waged against this marine animal that it soon became extinct in this part of the Gulf. It is claimed that there may still be seen the ruins of the post of the Royal Company of Miscou, which was founded in 1635 for the prosecution of walrus fishing etc., and for a time derived a great revenue therefrom. The island takes its name from the mission of St. Charles de Miscou, established here at an early date by the Jesuits. For further information see Perley's Reports on the Fisheries of New Brunswick and Hind's Preliminary Report on the Geology of New Brunswick, 1865.

Estuarine Flats.

Estuarine flats, great breadth of.

Estuarine flats occupy areas of greater or less breadth in Miscou and Shippegan harbours and in Pokemouche and Tracadie lagoons. In the mouths of the several rivers debouching into Miramichi Bay, and also among the islands which occupy it, wide expanses of sand, called "sandbars", are either laid bare at ebb tides, or covered only with a few inches of water. These usually support a dense growth of marine plants.

The general character of these formations was discussed in previous reports, and it is therefore unnecessary to go into further details regarding them.

Agricultural Character, Sylva, Etc.

General agricultural character of the district.

The agricultural character of the district under consideration presents no new features, except such as have been incidentally mentioned in previous pages of this report. The soils and subsoils bear, perhaps, a closer relation to the underlying rocks than in the coastal areas of the Baie des Chaleurs basin, and are likewise deeper, usually masking the strata completely everywhere, except on the Pre-Cambrian belts. Even where the surface is strewn with boulders foreign to the particular locality, the great bulk of the deposits belongs to the underlying rocks. The denudation which the region has undergone has carried away much of the finer material from the higher grounds and slopes, however, often leaving only a coarse gravelly or shingly soil. In the valleys there is usually a thick deposit of clay, gravel and loam, and wherever the latter is found, the soil is rich and productive.

Soils upon the Middle and Lower Carboniferous Rocks.

Soil of Carboniferous area above 200 feet contour lines.

The general character of these soils as met with in the Baie des Chaleurs district was described in some detail in my last report (Annual Report, 1886), and the remarks therein respecting them, especially as occurring in eastern Gloucester, are also applicable to those of the district now under discussion. On that part of it above the 200 feet contour line, the soil, more especially on the drier grounds (leaving out of consideration the vegetable layer usually occupying the surface), is a dry stony gravel or sand with an admixture of clay in certain localities. Where the sand and gravel predominate, it is exceedingly porous and light, but where clay prevails it generally has a hardpan underneath, and, if flat, is often wet and swampy. This hardpan, which is almost impervious to water, consists of fine sand and clay, with more

or less gravel intermixed, and is in some places stratified, in others a true till. It is found in flat districts or in low inland valleys where it is often covered only by the vegetable layer referred to on a previous page, which is here thicker than upon the ridges. Where there is sufficient slope to afford good drainage, the clay soils are usually fertile, but as they are wanting in organic and calcareous matter they require frequent applications of fertilizing material to render them productive. The low flat or undulating tracts, however, need, besides this, a proper system of draining. Without it, except in very dry seasons, their productiveness is much less than that of the drier grounds.

Soil of Carboniferous area below 200 feet contour line.

Below the 200 feet contour line the soil is, generally speaking, much superior to that inland. The surface has usually a gentle slope towards the Gulf shores and on this account is better drained, while along many of the river valleys, alluviums prevail. Bay du Vin, Black River and Napan valleys, more especially the latter, contain land of excellent quality, the upper portion of the soil partaking somewhat of a loamy consistency. On the north side of the Miramichi estuary, from Newcastle to Bartibogue, the coarser material of the surface deposits only seems to be left upon the slopes, although immediately bordering the coast there are strips of good land. Further north, between Bartibogue and Tabusintac, the coastal area is generally low and wet, but contains some arable tracts. The back settlements here are, however, located upon good dry soil. Between Tabusintac and Tracadie a wide sandy plain occurs, mostly unsettled, but around the latter place and at St. Isidore, excellent tracts of farming land are found.

Shippegan and Miscou Islands have but few settlers, and these devote most of their time to fishing. The land is low, and most of it poor and wet.

Returning to the Miramichi River, we find many fine tracts of land occupied and in a good state of cultivation upon the Middle and Lower Carboniferous areas along the North-West and South-West branches. The slopes afford good drainage and the soil is deep and capable of being raised to a high state of fertility by judicious and careful tillage.

Improvement of soil.

For the improvement of the soils overlying the Carboniferous area, lime appears to be the great *desideratum*. Considerable quantities of it are now applied in a slaked state. Near the coast of the Gulf and along the estuaries, inexhaustible supplies of mussel-mud are obtainable, which contains a large percentage of lime and constitutes a valuable fertilizer. This material is, however, only used yet to a limited extent.

Flora or sylva.

The flora of the district occupied by the Carboniferous rocks is closely similar to that described in report M (Annual Report, 1886) as occurring in eastern Gloucester, the distribution of the species in

New growth since Miramichi fire of 1825.

certain localities being, however, somewhat different, especially within the area burnt over by the great Miramichi fire of 1825. Outside of that area, hemlock, black and white spruce, fir, black, white and yellow birch, maple, beech, poplar, white and red pine, etc., are the principal trees on the drier grounds. On the swamps and intervales, cedar, hacmatac (larch), ash, elm, balsam-poplar, etc., occur. There is, generally speaking, a heavy growth of wood, except where the original forest has been destroyed by fires. Within the area overrun by the great Miramichi fire referred to, a growth of trees has sprung up which is in some respects different from that destroyed. Large groves of poplar on the damp grounds, and white birch, maple and beech on the drier, were especially noticeable, each of these growing in spots to the almost entire exclusion of any other tree. Upon the sandy and gravelly tracts, however, groves of red pine and black spruce are the prevailing forms, while along dry river banks, white spruce is the most abundant tree. The latter has attained, since the fire, a thickness of 12 to 15 inches above the roots. Hacmatac (larch) is common in bogs. The hemlock does not seem to have grown again after its destruction. In general the young growth of trees forms a dense forest.

Character of Soil upon the Cambro-Silurian Belts.

Soil of Cambro-Silurian area, quality of.

Of the two belts of Cambro-Silurian rocks crossing the district, that adjoining the Carboniferous is the lowest and contains the best lands. Many parts of it are boulder-strewn, but along the Nepisiguit, the main North-West Miramichi and Big Sevogle (see Dr. Ells' reports, Reports of Progress, 1879-80 and 1880-81-82) there are some tracts containing excellent soil. North of the Nepisiguit, about the head-waters of Little and Pabineau rivers, there are also areas of fine land, well suited for agricultural purposes but still in a wilderness state.

Trees upon it.

On the north-western band of these rocks the land is higher and appears to be more boulder-strewn. Both are still largely covered with a heavy growth of birch, maple, beech, spruce, pine, etc. The river valleys are generally pretty wide and contain flats with excellent soil.

The wide terraces along the Big Sevogle (see map) are clothed with a dwarfed growth of red and Banksian pine 10 to 20 feet in height. The flats support elms, poplars, etc. Strange to say, the last mentioned trees, even within the limits of the great fire of 1825, seem, in many places, to have escaped its ravages.

Soil upon the Pre-Cambrian Rocks.

Soil of Pre-Cambrian rocks, general sterility of.

Reference has already been made to the great amount of rock debris strewn over the surface of that part of the country occupied by these rocks, and its consequent general sterility noted. The mountain summits and flanks often exhibit little else than a mass of loose boulders and coarse shingle, the result of ages of disintegration. Along the foot-hills and in the valleys, however, there are limited areas of cultivable soil, while narrow intervales and terraces usually skirt the rivers. A considerable part of this district has been overrun by forest fires, and the covering of trees thus destroyed has never been replaced. Isolated clumps still occupy the lower portions of the slopes in places, however, and shroud the valleys and ravines.

Settlements, where located.

The settlements within the Miramichi district are chiefly confined to the tracts bordering the coasts and estuaries. This is more especially the case on the north side of the river, as on the south side, in addition to the coast settlements, there are a number of others along the tributaries and behind the towns, as will appear on the map. Many of the latter are in a thriving condition, the general agricultural character of the country here being very good.

INDIAN ENCAMPMENTS.

Indian camping grounds.

Old Indian camping grounds, in which flint arrow-heads, chips, bones and teeth of animals, etc., occur, were observed at the mouth of Tabusintac River and on the banks of the South-West Miramichi a few miles above Derby Junction. There seems to have been a burial ground in rear of the camp site at Tabusintac, human remains and a copper kettle having been found there.* A leaden crucifix, an iron hatchet, and other evidences of the intercourse of the early French settlers with the Indians were also discovered. A number of the relics were collected by Dr. A. C. Smith, of Newcastle, and Dr. Baxter, of Chatham, and forwarded to the Natural History Society of New Brunswick and a paper relating to these pre-historic remains appeared in *Bulletin* No. V. of that Society. An examination of this Indian camp site during the past summer, in company with Dr. Smith, elicited the following facts:—The site of the encampment is only three to five feet above high tide level, and the sea is washing away the bank. Fig. 3 represents a geological section of the beds—*a*, millstone grit; *b*, the same partially, and in the

Relics found.

* The human remains were supposed to be those of an Indian, and were buried three feet deep in the river's bank in rear of the camp-site.

a, Sandy loam. *b*, Rotted rock. *c*, Middle Carboniferous sandstone.
FIG. 8. SECTION AT INDIAN CAMP-SITE, TABUSINTAC RIVER.

upper part wholly, decomposed from subærial action; and *c*, a sandy loam apparently formed from the further oxidation of the underlying gravel or sand and mingled with more or less recent sand thrown up by the sea. Only in division *c* do the relics occur. Division *b* appears to have been undisturbed, and there is no evidence of a submergence since the deposition of the Saxicava sands, (of which in reality *c* may form a part) or from the commencement of its occupancy by the Indians, as inferred by the writer of the article in the *Bulletin* just cited.

How entombed.

The entombment of the relics in division *c* has been effected partly, perhaps, by the *rejectamenta* of the Indians, but principally by atmospheric action and tillage, none appearing deeper in the soil than the plough could cover them. From the numerous stone chips, unfinished arrow-heads and others of more perfect form, as well as the relics showing contact with the early European settlers just referred to, it seems probable that the Indians occupied this camp site continuously from a very early period until recently. About the year 1860 they are said to have left it never to return.

MATERIALS OF ECONOMIC IMPORTANCE.

Economic materials.

The materials of economic importance known to occur in this district have been incidentally referred to in preceding pages, and are brick-clay, fine sand, gravel suitable for roads, ballasting railways, etc., peat and bog iron-ore, the latter in small quantities.

Where found.

Brick-clay of marine formation (Leda clay) is found in great abundance along the estuary of the Miramichi, and brick-kilns are in operation at Chatham, Newcastle and Nelson. The one at the last mentioned place is the largest and the bricks manufactured there are reported to be of excellent quality. Sand beds (Saxicava sand) occur in proximity to these brick yards, affording supplies of sand suitable for brick and mortar. Both Saxicava and recent sands of the finest quality for the purposes mentioned are abundant almost everywhere along the coast of this district (see p. 26 N, this report,) for description of sand dunes).

Gravel adapted for the purposes referred to was met with in the vicinity of Chatham, Douglastown, Newcastle, Bartibogue and numerous other localities.

Peat is abundant and of great thickness and excellent quality. Should this article ever be required for fuel in northern New Brunswick, or for any other purpose, there is here an almost inexhaustible supply. The particular localities where the larger peat bogs occur, together with brief descriptions of them, are found on pp. 22-25 N, (this report.)

Bog iron-ore was observed on the south side of Tracadie River in small quantities. It was also noted on the North-West Miramichi in the vicinity of Chaplin Island. Clay associated with it and coloured therefrom is, at the latter place, used as a red paint for the outside of buildings.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

THE

MINERAL WEALTH

OF

BRITISH COLUMBIA.

WITH AN ANNOTATED LIST OF LOCALITIES OF MINERALS
OF ECONOMIC VALUE.

BY

GEORGE M. DAWSON, D.S., F.G.S.,

Associate Royal School of Mines.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1889.

To Dr. Alfred R. C. Selwyn, C.M.G., LL.D., F.R.S.
Director of the Geological and Natural History Survey of Canada.

Sir,—In 1877, I prepared, in connexion with the Government Surveys for the Canadian Pacific Railway, a general note on the Mines, and Minerals of Economic Value of British Columbia, which was published in the Railway Survey Report for that year, and was afterwards reprinted, with some additions, in the Report of Progress of the Geological Survey for 1877-78. Since that time great changes have occurred in respect to the aspects of mining in British Columbia, and important additions have been made to our knowledge of its mineral resources and geology. In view of these, and the increasing interest now manifested in the development of the natural resources of the province and the numerous enquiries constantly received on that subject, it appeared to be desirable to place the available information respecting its mineral wealth in the hands of the public in a summarized form. With this object in view I began the revision of the publication first referred to, but soon found that in order to obtain a reasonably satisfactory result, it would be necessary practically to rewrite the whole. The work has, in consequence, assumed proportions larger than were at first contemplated. I have had an opportunity of personally examining most of the important localities here described. Other places have been examined by yourself, by the late Mr. James Richardson and by Mr. Amos Bowman. For a few which have not been visited by any member of the staff of the Survey, information has been drawn from other trustworthy sources.

I have the honor to be, Sir,

Your obedient servant,

GEORGE M. DAWSON.

Ottawa, *March* 1, 1889.

NOTE.—The ton referred to throughout this report is the ton of 2000 lbs., unless otherwise stated.

THE

MINERAL WEALTH

OF

BRITISH COLUMBIA.

By GEORGE M. DAWSON, D.S., F.G.S.

The object of this publication is two fold. It is, in the first place, intended to serve, in some measure, as an exponent of the mineral wealth of the Province to which it refers, to provide an answer of a general kind to the enquiries now so frequently made on this subject, and to collect for this purpose in a convenient form brief summaries of the facts contained in the several official reports on the geological features of the Province, with specific references to the pages in which they are treated of at greater length. In the second place, it is designed to place in the hands of the 'prospector' or miner a convenient synopsis of facts, with a list of localities likely to be of interest to him. In the endeavour to carry out this second purpose, it has been considered advisable to add notes on such general principles, and to advance such suggestions, as from my study of the geological features of the Province, (dating from 1874) appear to be of importance, and likely to be of service at the present time in guiding the search for or exploitation of its metalliferous deposits. In further pursuance of this object, some facts resulting from late practice and investigations in other mining regions are alluded to, and their application to the problems of development in British Columbia is briefly noted. Object and plan of report.

The treatment of the various subjects included in this publication is necessarily more or less unequal, and no one can be more fully alive than the writer to its incompleteness in many respects. While the important developments now in progress in the Province appear to call for the present publication, it is to be anticipated, that within a short time anything that can now be said regarding vein-mining will be relegated to a position of merely historical interest.

In connexion with the preparation of these notes, I have had occasion to apply to several gentlemen for information, which has been Acknowledgements.

readily and cordially supplied. I am under obligations particularly Messrs. G. M. Sproat and A. W. Vowell, Gold Commissioners for K tanie District; to Mr. G. B. Wright, and for some special notes to M R. D. Atkin, J. W. McKay, J. F. Allison, S. Robins and Hon. Dunsmuir. Much assistance has also been received from Mr. Am Bowman, and in the matter of assays and analyses from Mr. G. Hoffmann.

General Physical Features.

Area and position of British Columbia.

The Province of British Columbia, with an area of 390,344 squa miles, includes a length of over 800 miles of the Cordillera belt of t West Coast, a region of mountains and of geological disturbance, whi in this part of its extent has, between the Pacific Ocean and t elevated western margin of the Great Plains, a breadth averagi about 400 miles. This great mountain region extends north-westwa and south-eastward, and constitutes the effective cause which has p duced the similar trend of the Pacific coast between the same par lels of latitude. It represents the northern continuation of the mo important metalliferous area of the United States, essentially repe ing its main orogrophic features, though presenting also some notal differences of a general kind as well as many local peculiarities.

The Cordillera belt.

The Cordillera belt, in British Columbia, may be described as com prising four great mountain systems or principal axes of uplift a geological disturbance, which are, in the main, nearly parallel to ea other and to the coast,—the Rocky, the Gold, the Coast and the Va couver ranges.

The Rocky Mountains.

The Rocky Mountain Range proper, is the furthest inland, and h an average breadth, in its southern part, of about sixty miles, but decreased near the Peace River to forty miles or less, and apparent loses its importance and regularity locally where cut through by t Liard, though recovering both still further to the north-westwa Near the 49th parallel, several summits occur in this range whi exceed 10,000 feet in height, but northward, few attain this ele tion till the head-waters of the Bow River are reached. Abo the sources of the North Saskatchewan and Athabasca, the ran appears to culminate, and Mounts Brown and Murchison occu with reputed heights of 16,000 to 13,500 feet respectively. Near t Peace, few summits exceed 6000 feet, so far as known. Though mo or less extensive snow-fields occur in many places, true glaciers a found only about the heads of the Bow, North Saskatchewan a Athabasca. Some of the valleys penetrating this range on the ea

are lightly timbered or in part prairie-like in character, but, as a rule, the mountains are thickly wooded wherever sufficient soil exists for the support of trees, and owing to the greater rain-fall on the western slopes of the range, the forests are there often very dense.

Rocks of the Rocky Mountains.

Crystalline schists and granite, are scarcely known in any part of the Rocky Mountains between the 49th and 60th parallels, the ranges being built up chiefly of a great series of Palæozoic rocks, extending from the Cambrian to the Carboniferous, with a total thickness of more than 28,000 feet in the Bow River region. There are also, however, more or less isolated basins of rocks of Cretaceous age, which rocks were evidently at one time continuous with those of the same age in the eastern foot-hills and Great Plains. In these basins, beds of bituminous coal and of anthracite are found. Deposits of copper-ores and of galena are so far the most important metalliferous minerals discovered in association with the older rocks of this mountain system.

Valley to south-west of Rocky Mountains.

The south-western side of the Rocky Mountain Range, is defined by a very remarkable, straight and wide valley, which can be traced uninterruptedly from the 49th parallel to the head-waters of the Peace,—a distance of 700 miles or more. This valley is occupied by the upper portions of several of the largest rivers, including the Kootanie, Columbia, Fraser, Parsnip and Finlay. Gold-placers have been found and worked at a number of points along this valley, and important discoveries of various ores are now being made in its vicinity near the Upper Columbia and Upper Kootanie. It is naturally adapted to become a main line of communication between the southern and northern portions of the Province, near its eastern boundary.

The Gold Range.

The next mountain system to the south-west of the Rocky Mountains, is referred to under the general name of the Gold Range, though really a complex and somewhat irregular mountainous belt, which includes several more or less distinct and partly overlapping ranges. The Purcell, Selkirk and Columbia* ranges constitute its southern part, while to the north it is represented by the Cariboo Mountains, and still further northward,—after an important interruption,—by the Omenica and Cassiar mountains. These mountains are, generally speaking, less rugged in detail than the Rocky Mountains, including extensive areas of high, rolling plateau-country, and supporting in their southern and more massive portion, numerous glaciers and wide snow-fields. The highest summit so far actually measured is Mount Donald, on the line of the Canadian Pacific Railway, 10,645 feet. The forests of the Purcell, Selkirk and Columbia ranges are dense and tangled, and these mountains are much more difficult to traverse, and even less perfectly explored

* The name Gold Range is often specially applied to that here spoken of as the Columbia Range.

than the corresponding portion of the Rocky Mountains. Granites and crystalline schists of great age are abundant in the Gold Range, together with great masses of Palæozoic rocks, respecting the structural relations of which very little is as yet known.

Principal metalliferous belt.

The Gold Range, as a whole, doubtless constitutes the most important metalliferous belt of the Province. The richest gold-fields are closely related to it, and discoveries of metalliferous lodes are reported in abundance from all parts of it which have been explored. The deposits already made known are very varied in character, including highly argentiferous galenas and other silver-ores and auriferous quartz veins.

Interior Plateau of British Columbia.

Between the Gold and Coast ranges, lies a region, which for purposes of description, has been named the Interior Plateau of British Columbia, having an average width of one hundred miles and a mean elevation of about 3500 feet. Its height, on the whole, increases to the south; while northward, it falls gradually toward the group of large lakes and the low country about the head-waters of the Peace. This has, over a considerable part of its area, been covered by wide-spread flows of basalt and other volcanic rocks in the later Tertiary period. It is now traversed in various directions by a system of deep, trough-like valleys of erosion, generally occupied by streams and rivers. Water standing at an elevation of three thousand feet above the present sea-level would flood most of these, and would divide its surface into a number of islands, while a large tract of country about the 53rd and 54th parallels of latitude would be completely submerged. In some places the plateau is pretty level and uniform, but many portions of it attain an elevation much exceeding the mean above stated, and it is usually only when broadly viewed, and in contrast with its bounding mountain ranges, that its character as a plateau is apparent. Its main area is practically closed to the north, about latitude 50° 30′, by the ends of several intercalated mountain ranges, in which many of the summits attain a height of 8000 feet. Nearly coincident with the 49th parallel, is a second transverse mountainous zone, formed in the same way, the only orographically important gap in which is that found in the vicinity of the Okanagan River. The southern portion of the Interior Plateau includes much open country, constitutes the best grazing region of British Columbia, and affords besides some good agricultural land. To the north, with increasing moisture, it becomes generally forested, but embraces large areas which are suitable for eventual agricultural occupation.

Geology of the Interior Plateau.

The Tertiary rocks of the Interior Plateau hold, in many places, beds of lignite or of coal. Where not concealed by the later rocks, the formations preponderantly represented belong to the Palæozoic age.

These include very notable developments of materials originally volcanic in origin. The geological structure is scarcely less complex than that of the mountain regions, and much yet remains to be done toward its elucidation. The Interior Plateau also presents some important granitic areas, and, particularly toward its south-western border, limited basins of Cretaceous rocks. As a metalliferous region, it is destined to take high rank, particularly I believe in respect to the precious metals, though its ores are too varied in character to admit of description in a few words. Placer deposits of gold have been worked in a number of widely separated localities, and platinum is abundant in the Similkameen region.

The Coast Ranges of British Columbia.

The Cascade Range of Oregon and Washington is largely composed of erupted volcanic materials, to which its characteristic features are due, though these materials rest upon a basis of older rocks. Its course is north-and-south, and it is definitely terminated in the vicinity of the International boundary. Near the mouth of the Fraser River its place is taken by a new mountain system, geographically and geologically distinct, in the composition of which volcanic ejectamenta play no prominent part. This forms the third member of the Cordillera in British Columbia, and under the name of the Coast Ranges, pursues a direct north-westward course for over 900 miles, forming throughout this distance the bordering mountain-zone of the continent. The Coast Ranges have an average width of about one hundred miles, and consist of numerous constituent ridges and minor mountain axes with varied trends, frequently separated by deep parallel and transverse valleys. The average altitude of the higher summits is between 6000 and 7000 feet, while some exceed 9000 feet. Glaciers are of frequent occurrence, and large in size, in the northern portions of the Coast Ranges. The mountains are, as a rule, densely forested and extremely rugged, the flora of their seaward slopes being that characteristic of the West Coast and coördinated with its great humidity, while on north-eastern flanks the forest resembles that of the inland ranges.

Rocks of the Coast Ranges.

Geologically, the Coast Ranges owe the greater part of their elevation to a period later than the Cretaceous, of which formation patches are found in them at great heights. The rocks consist chiefly of grey granites and granitoid materials, with which are associated gneisses and other crystalline schists, as well as Palæozoic rocks resembling some of those of the Interior Plateau. In association principally with the last-named rocks, gold-placers occur locally. Copper- and iron-ores are frequently found, and rich silver-ores have been discovered.

The name Vancouver Range, may be applied as a general one to the fourth great mountain-axis, which, in a partially submerged condition,

The Vancouver Range.

appears in Vancouver and in the Queen Charlotte Islands, and is continued southward nearly to the Columbia River by the Olympian Mountains of Washington Territory. The islands of the Alaskan archipelago have, on the map, the appearance of constituting a northern continuation of the same mountain system, but I believe that they may be more appropriately regarded, from an orographic point of view, as forming a partially submerged lateral expansion of the Coast Ranges. The highest mountain of Vancouver Island—Victoria Peak—reaches an elevation of 7484 feet, while there is a considerable mountainous area in the centre of the island, which surpasses 2000 feet in average altitude. Several summits in the Queen Charlotte Islands exceed 4000 feet.

Rocks of the Vancouver Range.

The Vancouver Range, while still to a considerable extent formed of crystalline rocks like those of the Coast Ranges, is principally composed of stratified rocks of Palæozoic and Triassic age, and is flanked in places, both on Vancouver and on Queen Charlotte Islands, by Cretaceous rocks, which are here important because of their coal-bearing character. The areas underlain by these rocks are in general comparatively low, and hilly rather than mountainous, while a large tract of level land, based upon the Tertiary formation, occurs in the north-east part of the Queen Charlotte Islands. Gold-placers have been worked in several places on Vancouver Island, but few ever attained much importance. Iron, copper and lead ores and gold-bearing quartz are also known to occur in connexion with this mountain-axis, but up to the present time the coal deposits have proved to be vastly its most important feature.*

General Notes on Mineral Deposits.

Similarity of rocks in different parts of Cordillera belt.

The general correspondence of that portion of the Cordillera belt included in British Columbia with that of the western portion of the United States, in some parts of which mining operations of the first importance have been in progress now for many years, has already been alluded to. No feature of the geology of the continent is more remarkable, than the general persistence of certain zones of similar rocks in a direction coincident with that of the Cordillera itself,—a circumstance in part due to the original similarity in conditions of depo-

* In connexion with the foregoing outline of the ruling physical and geological features of the Province, it should be stated that while these features are moderately well known in the southern portion of the Province, and as far northward as the 50th degree of latitude, and that while in connection with the Yukon expedition some accurate information has been obtained for the extensive northern portion; there yet remains a large region, chiefly included between the 50th and 58th parallels, which, though touched upon here and there by the gold miner, is yet almost unknown geographically and geologically.

sition of sediments, and in part to their equal participation, at a later date, in changes produced by like metamorphic agencies. The similarity thus observed, in a series of geological zones parallel to the general direction of the Pacific Coast, is here more striking than the continuity of the constituent orographic uplifts of the mountain-belt, and contrasts very markedly with the diversity of rock-formations found to occur where this belt is crossed at right-angles. While metalliferous deposits individually are inconstant, and even the best defined lodes can be followed, in the vast majority of cases, for but a moderate distance, their character is found to depend fundamentally upon that of the enclosing or adjacent rocks, in which, under the required local dynamic and other agencies, these deposits are found to recur with nearly identical features. It is not intended here to discuss the resemblances and differences of the various rock-series met with in the corresponding region in the Western States with those of British Columbia, but it may be mentioned, that the metalliferous districts of the Province may with advantage be compared by the miner with those which have already been more fully developed in each corresponding portion of the Cordillera region to the south, and that from such rational comparisons, useful indications may be derived in the present early stages of the development of the mines of British Columbia.

Continuations to the southward of various mountain ranges.

The Rocky Mountains proper, as defined on a previous page, can scarcely be traced southward, with identical characters, further than the main head-waters of the Missouri, beyond which the eastern ranges of the Cordillera become more lax and irregular. The Gold Range may, however, be followed further in a southerly direction, being continued by the Cabinet, Cour D'Alaine and Bitter Root mountains, for about 300 miles. The Interior Plateau of British Columbia represents the Great Basin of Utah and Nevada and the great plains of the Columbia, and combines to some extent the features of both, though differing markedly from the first in the fact that it is not here self-contained as to its drainage, and from the second, in the diminished importance of its Tertiary lava-flood. It has already been stated, that the Coast Ranges of British Columbia are not continued to the south of the International Boundary. They resemble the Sierra-Nevada more closely than they do the Cascade Mountains of Washington Territory and Oregon, and hold a similar relation to the Interior Basin with that held by the Sierra. While, however, the Sierra owes its elevation to a time immediately antedating the Cretaceous, the main uplift of the Coast Ranges of British Columbia occurred at or after the close of that period. The Vancouver Range, again, dating from the same period with the last, is not traceable south of the Columbia River, beyond which, in Oregon and California, the Pacific is bordered by a

range of coast hills, which, from a geological point of view, are of very recent origin.

Auriferous rocks of British Columbia and California compared.

In California, the principal auriferous territory coincides with the run of a certain belt of slaty and schistose rocks, which occurs on the western flank of the Sierra-Nevada; these rocks being referred by their contained fossils, to the Triassic and Cretaceous divisions of the geological scale. In British Columbia, while rocks of Triassic age are largely developed, and in some cases with characters identical with those of the Californian gold bearing rocks, no such persistent belt of these rocks is found in connexion with the Coast Ranges, where (from what has just been said of the resemblance of the two mountain systems) it might, from analogy, have been sought for. While local occurrences of rich gold-placers are known, in association with slates probably of Triassic age, on both sides of the Coast Ranges, the main auriferous territory in the Province is found to align itself on the Gold Range; and the original deposits of gold, from which the placers have been supplied, are already known to exist in different series of rocks widely separated in age and ranging all the way from the Triassic to the Cambrian. While, therefore, there is no single well developed gold-producing region, as in California, the area and mass of the rocks throughout which deposits of gold may be hopefully looked for, is here greatly increased. The circumstances would also warrant the belief, that the mode of occurrence of gold in its original matrix might differ from that found to the south, and in particular that this might be more varied. So far as investigation has gone such a belief appears to be well grounded, and it would seem, that to a very considerable extent, the natural laws of this mining field must be worked out independently.

No Tertiary Coast Ranges in British Columbia.

In correspondence with the absence of the Tertiary Coast Hills of California, in which, under peculiar conditions of mineralization, the cinnabar ores of that State are developed, it is observable that in British Columbia no really important deposits of mercury have yet been discovered. It is by no means improbable that mercury-ores may yet be developed in the Province, but if so, it cannot be in any continuation of the Californian cinnabar belt, and the conditions of such deposits may be expected to prove unlike.

Coal-bearing Cretaceous rocks of British Columbia.

Another and very important point of diversity, is found as respects the Cretaceous rocks of the southern and northern coast regions. In California and Oregon, the mineral fuels which have been found and worked are lignites of Tertiary age and of an inferior value. Similar fuels are known on the coast of British Columbia, but the rocks of the Cretaceous here assume the *rôle* of a coal-bearing series and yield coals of excellent quality, which more than hold their own in competition with all other fuels employed on the Pacific.

Effects of glaciation.

Still another noteworthy circumstance of difference, and one which is applicable to practically the entire area of the Province when it is contrasted as a whole with the Pacific States, is that which has been produced by the general spread and movement of ice over this region, during the Glacial period. The changes thus effected in the distribution of surface materials and directions of drainage have most important bearings on the question of placer mining. They have also encumbered the surface of considerable tracts with "drift" deposits, which, while tending to produce a more fertile soil, largely conceal the indications to which the prospector generally trusts in more southern latitudes. At the same time, a great part of the oxidised upper portions of metalliferous veins, together with the atmospherically decayed country-rock associated with these, has been removed, thus often obscuring the outcrops of such veins, which would otherwise be well marked; and in the treatment of certain classes of ores, rendering it necessary to begin work from the first with machinery and processes which in some other regions are only required after considerable depths have been attained.

Causes which tend to retard development.

These conditions, brought about by action during the Glacial period, are amongst those which, in my opinion, have most tended heretofore to retard the development of metalliferous mining in British Columbia. Other circumstances which have operated in the same direction are; the densely wooded character of a great part of the country, the fact that the rivers are suited for navigation only in detached reaches, the remoteness from the coast of the richest and best known placer-mining districts, and the cost of labour, supplies and machinery, which may be regarded as in part concomitants, in part direct results of these. Owing to the inaccessibility of the country, it has, till very recently, been prospected and exploited by the placer-miner alone, who has been deterred by no difficulty from reaching the most remote spots in which rumour, or reasoning of his own, lead him to expect the existence of the precious metal. Little knowledge or effort was expended in the search for metalliferous veins. Many such deposits supposed to be of value were, it is true, located, and time and money which could ill be spared, often uselessly spent upon them, leading only to discouragement. Even where the indications met with were altogether favourable, the original discoverer generally found that the capital and knowledge required for their development were not at his command, and it was difficult to interest those capable of dealing with such mines in a region which they could not easily visit and become familiar with at first hand. With regard at least to the whole southern portion of the province, however, all this is now happily changed.

Exaggerated values.

While speaking of causes which have hitherto stood in the way of vein-mining, it must also be mentioned, that not the least important of

these has been, and still is, the fictitious or exaggerated value too frequenty placed upon entirely undeveloped discoveries. While it is manifestly right that the discoverer should be properly remunerated, it should be remembered that a mere surface shewing, however promising, generally requires the expenditure of a large sum before its true value can even be ascertained, and that till thus developed it is unreasonable to expect a large payment for any mining claim.

Importance of British Columbia as a metalliferous region.

In preceding paragraphs, particular attention has been drawn to certain notable differences between the better known and more fully developed regions of the southern part of the Pacific Slope and those of the province of British Columbia, chiefly as a note of caution against the rash assumption of complete uniformity in conditions too often made without due investigation. The salient fact of the general identity of the structural features of the Cordillera region south and north, however, remain, and is such, that from this alone, even without taking into consideration the numerous and important discoveries already made, we should be justified in predicting an eventual great development of metalliferous mining in the Province. It has already been stated, that British Columbia includes a length of over 800 miles of the most important metalliferous belt of the continent, and adding to this the northern extension of the same belt, beyond the 60th parallel, we find that within the boundaries of Canada its entire length is between 1200 and 1300 miles. This, as I have elsewhere noted, is almost precisely equal to the whole length of the same region included by the United States from our southern line to the northern boundary of Mexico, and after having enjoyed, exceptional opportunities of investigation, I feel no hesitation in recording my belief that the northern moiety of the Cordillera will ultimately prove to be susceptible of a development corresponding in importance to that which has already been attained in the southern.

Rise and progress of mining.

British Columbia first rose from the position of a far country to the rank of a colony, on the discovery of gold upon the Lower Fraser in 1858. Its subsequent history, for a number of years, is substantially that of the sudden rise and subsequent slow decline in importance of placer gold-mining. Coal mining has, however, concurrently, advanced slowly but steadily till it has obtained its present pre-eminent position. Such historical facts as appear to be important to the appreciation of these industries are touched on later in connexion with them. With respect to vein-mining proper, we have as yet to chronicle merely the first steps, but in the southern part of the Province the completion of the Canadian Pacific Railway, has at length afforded the necessary impetus in this direction, and it is very gratifying to find, as an immediate consequence, that this part of the country is rapidly beginning to

Present position.

prove its valuable character and to justify the confidence which those best able to form an opinion on the subject have always felt, and frequently expressed. Everything which has been ascertained of the geological character of the Province as a whole, tends to the belief that so soon as similar means of travel and transport shall be extended to what are still the more inaccessible districts, these also will be discovered to be equally rich in minerals, particularly in the precious metals, gold and silver. In the southern district, for which information is most complete, praiseworthy efforts are now in progress at a number of widely separated localities, toward the exploitation of ores, which, in many cases, have already been proved to be of an exceptionally valuable character. Here at least, we have every reason to believe that we are on the point of witnessing the inauguration of an era of mining activity of the most important kind.

Publications Bearing on Geology, etc., of British Columbia.

The operations of the Geological Survey of Canada, were first extended to British Columbia in 1871, when the former colony became a province of the Dominion. Since that date a number of reports bearing on the Province have been published by the Geological Survey, which are here enumerated, as frequent reference is made to them on subsequent pages:— List of reports cited.

Report of Progress 1871–72.—*Selwyn:* Journal and Report of Preliminary Explorations in British Columbia. *Richardson:* On the Coal Fields of the East Coast of Vancouver Island, with a map of their distribution. Appended notes by *Dawson* (*J. W.*) and *Hunt* on Fossil Plants and on Coals.

Report of Progress 1872–73.—*Richardson:* On the Coal Fields of Vancouver and Queen Charlotte Islands, with a map of the former; an Appendix by *Dawson* (*J. W.*) on Fossil Plants; another by *Billings* on Mesozoic Fossils; and a third by *Harrington* on the Coals of the West Coast.

Report of Progress 1872–73.—*Richardson:* On Geological Explorations in British Columbia.

Report of Progress 1874–75.—*Richardson:* On Explorations in British Columbia.

Report of Progress 1875–76.—*Selwyn:* Report on Explorations in British Columbia, with sketch-map of route and appendices by *Macoun* on Botany; *Whiteaves* on Fossils; and *Le Conte* on Coleoptera.

Dawson (*G. M.*): Report on Explorations in British Columbia; Appendix by *Scudder* (*S. H.*) on Tertiary Fossil Insects.

Report of Progress 1876–77.—*Dawson* (*G. M.*): Report on Explorations in British Columbia, chiefly in the Basins of the Blackwater, Salmon and Nechacco Rivers, and on François Lake, with a coloured Geological map.

Dawson (*G. M.*): Report of a Reconnaissance of Leech River and vicinity.

Dawson (*G. M.*): General Note on the Mines, and Minerals of Economic Value of British Columbia, with a list of Localities.

Richardson: Report on the Coal Fields of Nanaimo, Comox, Cowicha[n], Burrard Inlet and Sooke, British Columbia, with a coloured Geologic[al] map.

Scudder (S.H.): Additions to the Insect Fauna of the Tertiary Beds [at] Quesnel.

Report of Progress 1877–78.—*Dawson (G. M.):* Preliminary Report on the Phys[i]cal and Geological Features of the Southern Portion of the Interior [of] British Columbia, with a coloured Geological map.

Report of Progress 1878–79.—*Dawson (G. M.):* Report on the Queen Charlott[e] Islands, with two coloured Geological maps and sketches of Harbour[s]. *Appendix A.*—On the Haida Indians of the Queen Charlotte Island[s]. *Appendix B.*—Vocabulary of the Haida Indians. *Appendix C.*—*Whiteave[s]:* On some Marine Invertebrata from the Queen Charlotte Islands. *Appen[*]*dix D.*—*Smith (S. J.):* Notes on the Crustacea from the Queen Charlott[e] and Vancouver Islands. *Appendix E.*—*Macoun:* List of Plants from th[e] Queen Charlotte Islands. *Appendix F.*—Meteorological Observation[s]. *Appendix G.*—Notes on Latitudes and Longitudes.

Report of Progress 1879–80.—*Dawson (G. M.):* Report on an Exploration fro[m] Fort Simpson, on the Pacific Coast, to Edmonton, on the Saskatchewa[n], embracing a portion of the Western part of British Columbia and th[e] Peace River Country, with a map in three sheets, with Geological Indic[a]tions. *Appendix I.*—*Macoun:* List of Plants collected in the Norther[n] part of British Columbia and the Peace River Country. *Appendix II.*—Meteorological Observations. *Appendix III.*—Note on Latitudes an[d] Longitudes of the Region from the Pacific Coast to Edmonton.

Dawson (G. M.): Note on the Distribution of some of the more importan[t] Trees of British Columbia, with a map.

Report of Progress 1882–84.—*Bauerman (H.):* Report on the Geology of th[e] Country near the Forty-ninth Parallel of North Latitude, West of th[e] Rocky Mountains, from Observations made 1859–61.

Annual Report, 1885.—*Dawson (G. M.):* Preliminary Report on the Physical an[d] Geological Features of that portion of the Rocky Mountains betwee[n] Latitudes 49° and 51° 30′, with two coloured Geological maps.

Annual Report, 1886.—*Dawson (G. M.):* Report on a Geological Examination [of] the Northern part of Vancouver Island and adjacent coasts, with [a] coloured Geological map. *Appendix I.*—*Whiteaves:* Note on some Meso[-]zoic Fossils from various localities on the coast of British Columbi[a]. *Appendix II.*—*Macoun:* List of Plants from Vancouver Island and adja[-]cent coasts. *Appendix III.*—Meteorological Observations.

Annual Report, 1887.—*Dawson (G. M.):* Report on an Exploration in the Yuko[n] District, N.W.T., and adjacent Northern portion of British Columbi[a], with an index map and a detailed map in three sheets, with Geologic[al] indications. *Appendix I.*—Note on the Distribution of Trees. *Appendix I[I.]*—Note on the Indian Tribes. *Appendix III.*—*Macoun:* List of Plant[s]. *Appendix IV.*—Zoology. *Fletcher (J.):* List of Lepidoptera, etc. *Appendi[x] V.*—*Adams:* Notes on Rock-specimens. *Appendix VI.*—Meteorologic[al] Observations. *Appendix VII.*—Astronomical Observations.

Bowman: Report on the Mining Region of Cariboo. Part I.

Besides the reports above enumerated, which are contained in th[e]

annual volumes of the Geological Survey, the following special reports bearing on British Columbia have been issued by the Survey:—

Mesozoic Fossils. Parts I., II. and III., by J. F. Whiteaves. *Report on the Polyzoa of the Queen Charlotte Islands* by T. Hinks' *Comparative Vocabularies of the Indian Tribes*, by W. F. Tolmie and G. M. Dawson.

Various contributions to the geology of the Province and to the knowledge of its minerals, including several short reports by Mr. A. Bowman, are also to be found in the Annual Summary Report of the Geological Survey, and numerous analyses of ores and minerals are included in the Contributions from the Laboratory of the Survey from 1871-72 to date.

From the Annual Reports of the Minister of Mines of British Columbia from 1874 to date, much valuable and detailed information may also be obtained.

In the following pages, placer gold-mining is given the first place, as it forms the natural introduction, from a historical stand point, to mining in general.

The Discovery of Gold.

The first authenticated discovery of gold within the limits of what is now the province of British Columbia, occurred at Mitchell or Gold Harbour, on the west coast of the Queen Charlotte Islands. This discovery created considerable interest at the time, but was in no way connected with the Fraser River excitement, and general commencement of placer-mining, which occurred later. As, however, the matter is of some historical interest, and as several versions of the affair have been given, the following notes derived from Mr. J. W. McKay, who was conversant with all the circumstances, at the time, are inserted here.—The first gold was a nugget accidently found by an Indian woman on the beach in 1851. After a part had been cut off, it was taken by the Indians to Fort Simpson and sold there, weighing, as received, between four and five ounces. The nugget was then sent by the officer in charge, to the Hudson Bay headquarters at Victoria. The Company in the same year sent the brigantine *Una* to the place of discovery, where a quartz vein seven inches wide and traceable for eighty feet was found, and reported to contain twenty-five per cent. of gold in some places. Some of the quartz was blasted out and shipped, but the brigantine was lost on the return voyage, at Neah Bay, near Cape Flattery, in the month of December. In January, 1852, a U. S. brigantine, named the *Orbit*, which was on the rocks in Esquimalt Harbour, was bought by the Company, registered under the British flag, re-named the *Recovery*, and sent north with thirty miners in addition to the ships company, the

Original discovery of gold in the Queen Charlotte Islands.

miners going 'on shares' in the venture. Three months were spen
getting a cargo of the quartz, which was eventually sent to Engl
the miners receiving $30 a month each as the result. Meanwhile,
discovery having become known, several little vessels from San F
cisco followed the *Recovery* to the Queen Charlotte Islands, and H. M
Thetis was sent from Valparaiso to keep order. The deposit pro
however, to be quite limited, and these vessels, as well as the *Th*
shortly left. Soon after, a vessel named the *Susan Sturgiss* arri
and the captain (Rooney) collected a quantity of the quartz which
been discarded by the *Una* expedition, and taking it to San Franci
realized $1400 on it. A second trip made by this vessel in the s
year, ended disastrously, the vessel being captured by the Indians
Masset, and the crew kept as prisoners for some time till released
the Hudson Bay steamer *Beaver*. It would appear that gold to
value of about $20,000 may have been obtained from this little v
while an estimate as high as $75,000 has been made.

Discovery of gold-placers.

It is now difficult to ascertain under what precise circumstances
first discovery of gold placers on the mainland of British Colum
occurred. Little attention was at first given to accounts of the find
of small quantities of gold, and at a later date, when gold min
sprung into importance, numerous stories respecting its discov
were invented or exhumed.* One statement, is to the effect that
Hudson Bay Company's agent at Kamloops had bought gold from
Indians as early as 1852, but, if correct, the amount purchased m
have been very small. In 1855, a servant of the same Company
covered gold near Fort Colville, a short distance south of the In
national boundary, and moderately rich diggings began to be wor
in that vicinity. It seems certain that the epoch-making discovery
gold in British Columbia, was the direct result of the Colv
excitement. Indians from the Thompson River, visiting a woman
their tribe who was married to a French Canadian at Walla-Wa
spread the report that gold, like that found at Colville, occurred al
their country, and in the summer or autumn of 1857, four or five Ca
dians and half-breeds crossed over to the Thompson, and succeeded
finding workable placers at Nicoamen, on that river, nine miles ab

Gold first obtained.

its mouth. On the return of these prospectors the news of the
covery of gold spread rapidly. It is also probable that their arriva
the Thompson caused the Indians to take an interest in gold-min
for we read in a despatch of Governor Sir James Douglas, that f
October 6, 1857, to the end of that year, three hundred ounces of g
had passed through the hands of the Hudson Bay Company,
amount being all, so far as known to Douglas, which had been obtain

*See Bancroft's Works, vol. xxxii, chapter xx.

Douglas speaks of the region including the Lower Thompson, from which the gold came, as the "Couteau Country."

Nearly ten years previously, in 1849, gold had been discovered in California, and that country was swarming with a cosmopolitan population of gold-seekers; thus when the discovery of gold in the north became known and authenticated by the exhibition of the gold itself, an extraordinary migration followed. Between March and June, 1858, from 20,000 to 23,000 persons arrived by sea from San Francisco in Victoria, and converted that place (first founded by the H. B. Company in 1843) from a quiet village of 200 or 300 inhabitants, into a city of tents. At the same time, many miners (estimated by some at 8000 in number) reached British Columbia by overland routes from the south. A large proportion of those who arrived at Victoria never got so far as the mouth of the Fraser River, their objective point, and so great were the natural difficulties and the resulting disappointment experienced, that all but about 3000 of this promiscuous migration returned to California before the following January. The inland country was entirely without routes of communication, by nature a singularly difficult one, and unprovided with means for the support of a large population. Meanwhile, by the more fortunate and energetic, the development of its wealth had been fairly inaugurated. The auriferous river-bars in the vicinity of Hope and Yale on the Lower Fraser being the most accessible, were the first to be worked, and the return of gold began to assume important dimensions. The actual shipments made from Victoria during the first five months of work in 1858, are stated as below *.—

Influx of gold-seekers.

First shipments of gold.

June	$ 6,000
July	45,000
August	45,000
September	164,000
October	283,000
	$543,000

Progress of Placer Gold-mining.

It is impossible here to follow the further progress of gold discoveries in British Columbia in detail, though such facts relating to discovery and former mining, as appear still to possess importance as guides to future development, are mentioned in connexion with the several dis-

* According to Macfie, Vancouver Island and British Columbia; London, 1865, p. 72. There are said to have been 4000 miners along the Fraser between Hope and Yale, in November, 1858. At Hope 400, and at Yale 1300.

tricts and localities to which they relate.* A few words must suffice to indicate in a general way the progress of the army of gold-miners, the outlines of the topographical features of the Province previously given, serving to acquaint those not personally familiar with it, with the salient features of the regions which were thus rapidly overspread.

Progress of mining 1858 to 1860.

Before the close of the working season in 1858, some of the adventurers who had come overland from the south, had pushed onward in face of extraordinary difficulties,—resulting not alone from the roughness of the country itself but combined with the want of supplies and occasional overt hostility of the Indians,—as far as Fountain, a short distance above Lillooet on the Fraser, and by the line of the Thompson to Tranquille River on Kamloops Lake. In the following year a renewed advance brought a number of miners to the Quesnel River, and in 1860, rich diggings were found at The Forks of the river and over 600 Whites were at work on its length, while Antler Creek was discovered and some work done upon it by a few score men,—thus fairly entered on the extremely rich central region of Cariboo. Also in this year, good placers were found on the Similkameen, in the southern part of the Province.

Theory of the miners

The theory formed by the miners who first worked the fine 'flour' gold of the Fraser below Yale, was that this gold had its origin in richer deposits toward the sources of the great river, and though this theory was only very partially correct as regards the origin of these particular deposits, it none the less served as the impelling force which led to the opening up of the Cariboo district.

Early discoveries in Cariboo.

In 1861, Williams and Lightning creeks, Cariboo, the two most celebrated in the annals of British Columbian placer-mining, were discovered, and in this and the following year most of the other rich creeks in Cariboo became known. The first gleanings from the old Cariboo stream-courses were notable. It is estimated that gold to the value of $2,000,000 had been got out by a population not exceeding 1500 before the end of 1861. In consequence of those finds a second important migration of miners and others towards the Province commenced before the close of 1861, which continued in greater or less volume till about 1864. A series of letters from a correspondent of the "Times" contributed largely to this result, and extended the area of interest to very wide limits, bringing adventurers from England,

* A mass of information respecting the historical and other features of gold mining in the Province is contained in Bancroft's Works, vol. xxxii, History of British Columbia. The details there collected may be consulted with advantage, and have been frequently referred to in connexion with localities mentioned in later pages of this report. It must be added, however, that many of the statements quoted by Bancroft must be accepted with caution, having been derived often from the newspapers of the time, and other sources not always trustworthy, but which it has naturally been impossible for the compiler to check, and many of which call for an intimate local knowledge of the country, even to properly correlate.

Canada, Australia and New Zealand. A party of men even set out for Cariboo from Eastern Canada overland, in 1862. Of this party several members lost their lives in the mountains, but some eventually reached their destination.

A further consequence of the Cariboo excitement was to depopulate almost completely the other mining camps in the Province, even those which were yielding a good average return for work, some promising localities lying untouched for years afterwards, or falling entirely into the hands of the Chinese and Indians.

Discoveries on Wild Horse Creek and Leech River.

In 1863, however, rich placer deposits were found on Wild Horse Creek in the Kootanie region, the extreme south-east portion of the Province. These caused considerable local excitement at the time. and were somewhat extensively worked in the following year and thereafter, notwithstanding the attraction of Cariboo. In 1864, Leech River, in the southern part of Vancouver Island not far from Victoria, was discovered to be auriferous, and in 1865 a number of miners from the Kootanie district were prospecting and working in the neighboring Big Bend (of the Columbia) country, the report of their success resulting in the Big Bend excitement of 1866. This subsided almost as quickly as it had arisen, the number of men who rushed to the place being much too great for the opportunities of work.

Gold on Peace River and Omenica.

Though miners from Quesnel, following the routes employed by the Hudson Bay Company, had reached and worked with some success on Peace River as early as 1861, it was not till 1869 that the richer deposits of the feeders of the Omenica Branch of that river near lat. 56° were discovered, and the Omenica excitement did not attain its height till 1871. In 1872, the rich northern mines of the Cassiar district, on the head-waters of the Dease, were brought to light, and a general migration in that direction occurred, which, in 1873, led to the almost complete abandonment of Omenica.

Cassiar and Yukon.

The discovery of the Cassiar mines carried the miners to the vicinity of the 60th parallel, the northern boundary of the Province. Gold was next found in paying quantities on the tributaries of the Yukon, still further to the north, in 1880.* No such rush has occurred to this district as happened in the case of some of those previously mentioned, but in 1886, the miners were at work as far north as lat. 64° 30′ having found 'coarse' gold there on Forty-mile Creek.

Granite Creek.

Granite Creek, a tributary of the Similkameen was found to yield rich diggings, in 1885, and though it has not proved to be as important as at first hoped, it has led to renewed activity in its vicinity.

* Whymper states, however, in 1869, that gold had been found in minute specks by employees of the Hudson Bay Company before that date. Travels in Alaska and on the Yukon, 1869, p. 227.

Region of the principal gold deposits.

While it may now be safely affirmed that gold is very generally di tributed over the entire area of the province of British Columbia, much so that there is scarcely a stream of any importance in which least 'colours' of gold may not be found, the enumeration of the pri cipal discoveries of important mining districts, shows very clearl that most of these are situated along the system of mountains and hig plateaux which comprises the Purcell, Selkirk, Columbia and Caribo ranges and their north-western continuations, lying to the south-we of the Rocky Mountain Range properly so called, and parallel in dire tion with it. Of all the gold-producing districts that of Cariboo h proved the richest and the most continuously productive.

YIELD OF GOLD.

Explanation of table annexed.

The first part of the annexed table, extending to the year 1875, w originally prepared in Victoria by Mr. Charles Good (then Deput Minister of Mines and Provincial Secretary) and the writer, in th winter of 1875-76. It was first published in the Annual Report of th Minister of Mines for 1875, and has since been republished annually i the same report, with the necessary additions. It is based througho on the amounts of gold shipped by the banks, express and other com panies from Victoria, this being the best available means of ascertainin the yearly product. It has from the first been impossible to ascertai the amount of gold annually taken away in private hands, largely b Chinese, and no account was obtained of the gold carried south from th Kootanie and Similkameen county, which did not pass through Victori To allow for these amounts, an addition of one-third is made to the amou actually known to have been exported, up to the year 1877. In som of the earlier years it is probable that this addition is an under-estimat while the reverse may hold in the case of the years immediately pr ceeding 1877. Subsequent to the year 1877, an addition of one-fift only has been made in the British Columbian report. It will thus b apparent that the figures given can only be accepted as a near appr ximation to the actual yield.

Under the year 1887 a small quantity of bullion obtained from quartz mine is added, but the amounts are otherwise entirely due placer-mining.

TABLE shewing the actually known and estimated yield of gold; the number of miners employed; and the average earnings per man, per year from 1858 to 1888, in the Province of British Columbia.

Gold product of British Columbia.

YEAR.	Amount actually known to have been exported by Banks, &c.	Amount added to represent gold carried away in private hands.	Total.	Number of Miners employed.	Average yearly earnings per man.
	$	$	$		$
1858 (partial return.)	543,000	....	*705,000	3,000	235
1859..........	1,211,304	1-3rd 403,768	1,615,072	4,000	403
1860..........	1,671,410	" 557,133	2,228,543	4,400	506
1861..........	1,999,589	" 666,529	2,666,118	4,200	634
1862..........	1,992,677	" 664,226	2,656,903	4,100	648
1863..........	2,935,172	" 978,391	3,913,563	4,400	889
1864..........	2,801,888	" 933,962	3,735,850	4,400	849
1865..........	2,618,404	" 872,801	3,491,205	4,294	813
1866..........	1,996,580	" 665,526	2,662,106	2,982	893
1867..........	1,860,651	" 620,217	2,480,868	3,044	814
1868..........	1,779,729	" 593,243	2,372,972	2,390	992
1869..........	1,331,234	" 443,744	1,774,978	2,369	749
1870..........	1,002,717	" 334,239	1,336,956	2,348	569
1871..........	1,349,580	" 449,860	1,799,440	2,450	734
1872..........	1,208,229	" 402,743	1,610,972	2,400	671
1873..........	979,312	" 326,437	1,305,749	2,300	567
1874..........	1,383,464	" 461,154	1,844,618	2,868	643
1875..........	1,856,178	" 618,726	2,474,904	2,024	1,222
1876..........	1,339,986	" 446,662	1,786,648	2,282	783
1877..........	1,206,136	" 402,045	1,608,182	1,960	820
1878..........	1,062,670	1-5th 212,534	1,275,204	1,883	677
1879..........	1,075,049	" 215,009	1,290,058	2,124	607
1880..........	844,856	" 168,971	1,013,827	1,955	518
1881..........	872,281	" 174,456	1,046,737	1,898	551
1882..........	795,071	" 159,014	954,085	1,738	548
1883..........	661,877	" 132,375	794,252	1,965	404
1884..........	613,304	" 122,861	736,165	1,858	396
1885..........	594,782	" 118,956	713,738	2,902	246
1886..........	753,043	" 150,608	903,651	3,147	287
1887..........	578,924	" 115,785	693,709	2,342†	296
1888..........	513,943	102,788	616,731	2,007	307

Total known and estimated yield of gold, 1858 to 1888... 54,108,804
Average number of miners employed yearly.......... 2,775
Average earnings per man per year.................. 622

* Waddington's estimate.

† Exclusive of a number of men working on or prospecting for quartz.

Changes made in table as here published.

In comparing the years 1858, 1862 and 1863 of the above table wi
the same years as represented in the table as formerly published, it w
be observed that the amount of gold is increased. This arises from t
circumstance that some additional returns of exports, not accessib
when the table was first prepared, have now been taken into conside
ation. These returns are to be found in Macfie's Vancouver Island a
British Columbia and in Bancroft's Works, Vol. XXXII. There appea
to be no doubt of the authenticity of these returns, and their additi
brings the average earnings of the miners employed in the years
question into better correspondence with the number of the miners a
with what is known of their success at the time.

Fluctuation in gold yield.

The most noticeable point brought out by the table is the great yie
of gold resulting from the discovery and early years of working in t
Cariboo district, and the gradual and scarcely interrupted decline
the product of the placers which has since occurred. The gold-yie
also, however, shows a fluctuation from year to year, particularly whe
it is considered in connexion with the number of men actually at wor
This depends not alone upon the uncertainty of the deposits work
and the development or otherwise of new fields, but also to a conside
able extent on varying climatic conditions, some seasons being ve
unfavourable to placer-mining on account of floods or prolonged hig
water.

Gold Mining Districts.*—*Placer.*

Fraser and Thompson Rivers.

Character of the Fraser.

The Fraser carries to the sea a great part of the entire drainage
the interior of British Columbia. At its mouth, the great quantity
detritus which it has brought down has formed an extensive delt
Followed up to the vicinity of Hope, its valley becomes defined b
bordering mountain-ridges which gradually converge to the mouth
the cañon at Yale. This lower part of the valley must be regarded
an ancient salt-water inlet which has been filled up by the materi
transported by the river, the harder and older rock-bottom of the vall
being generally covered to a great depth. Between Yale and Bost
Bar, (nearly opposite North Bend on the Canadian Pacific Railway
it breaks through the axis of the Coast Ranges, flowing in a series

* For administrative purposes, and in connexion with mining, the following districts are
cognised by the Government of British Columbia.—Cariboo, Cassiar, Omenica, Lillooet, Ya
West Kootanie, East Kootanie. Some of these districts are very extensive, and the term distr
is here employed in a more restricted, if somewhat less definite sense, as a convenient one un
which to group the various metalliferous occurrences. Thus the Cariboo district technica
includes the Parnip River and upper part of the Peace River, while from the point of vi
of placer-mining, these are more appropriately treated of under the heading Omenica.

wild rapids through a ragged gash in the mountains. Along the sides of this cañon a scarcely passable goat track existed when the gold-miners first arrived on the scene. Beyond Boston Bar, the valley becomes a direct and deep north-and-south furrow all the way to Fort George in latitude 54°. The southern part of this portion of the valley cuts obliquely through the inner tiers or flanking ridges of the Coast Ranges, but its northern and upper part is excavated in the plateau of the interior, to the east of these ranges. From the point of view of the gold-miner, the Fraser may be regarded as a gigantic ground-sluice. Its valley, originally excavated in Tertiary times, in the rocky substratum of the country, was subsequently, during the glacial period, largely filled with drift material; through which, at a still later date, the river has had to re-excavate its bed, leaving great series of terraces or "benches" along its banks in many places, as this was gradually accomplished. A portion of the gold now found in its bed and banks has without doubt been worn out of its rocky matrix directly by the action of the river and its immediate tributaries, while another portion may have been derived from the glacially transported drift materials. The first-mentioned moiety may be supposed to include the 'coarse' gold, the last must be in great part 'fine' gold.

Origin of the gold.

A great proportion of all this gold, from whatever source derived, has been gradually concentrated in the river-bottom by the action of the stream, while in many places paying deposits have been left upon the surfaces of 'benches' at various levels, or buried beneath their material, each such 'pay streak' representing some portion of a former bed of the river which has been left behind as erosion progressed. Thus when the work of 1858 and 1859 began, the miners obtained, with comparative ease and in a short time, a large quantity of gold. How much gold has been obtained from the Fraser and the lower part of the Thompson it is impossible to ascertain, but it may be stated that practically the entire output of the Province for 1857 and 1858, with the greater part of that for 1859, was derived from this river, and by far the larger portion from that part of the Fraser extending from Hope to the mouth of the Quesnel. The aggregate yield for these early years alone cannot be placed at less than $1,700,000.

Distribution and quantity of the gold.

The mode of working these gold deposits was comparatively a simple one. The so-called 'bars' were nothing more than portions of the river-bed, which, being left bare at low water, could be reached by the miner. They varied in richness not only in different parts of the length of the river, but also in correspondence with the local relation of the currents and set of the stream. They were worked generally to but a very limited depth, being often merely skimmed over, in con-

Character of deposits.

Mode of working.

sequence of the trouble from water and the cost of removing an considerable thickness of non-remunerative material to reach deepe underlying 'pay streaks.' Most of the work was accomplished wit the primitive rocker, and in 1858 no other means was employed on tha portion of the river below Yale. At Yale, and farther up, even in tha year, sluicing was resorted to in some places, and a number of sho ditches were constructed for the purpose of bringing water to the place worked. There were also, from the first, certain 'dry digging recognized and worked; these being auriferous layers in river-flats c benches which were above the high-water mark of the stream. Whe

Partial abandonment of the Fraser.

the exciting discoveries in Cariboo district became known, the Frase was almost abandoned, long before its placers had ceased to be rem nerative, but since that time more or less desultory work along th Fraser and Thompson has never ceased. A great number of the hig benches have been in part superficially worked, and have in some case yielded excellent results. In the bed of the river itself, at each seaso of flood, a partial re-arrangement of material occurs, and addition supplies of gold are brought in by the wearing away of the banks, feature having important bearings on the probable successful applic tion of hydraulic mining to some of these deposits.

Though no longer exceptionally rich, the bars and benches of th Fraser seem to afford a practically inexhaustible supply of gold. Ha no further discoveries occurred in the north, the Fraser would not s soon have been deserted by the energetic white population, but wit the gradual improvement in methods of mining would have bee made to yield a vastly greater amount of gold than it has yet produce Nothing illustrates this fact more forcibly than the table given below

Hill's Bar.

the annual yield of the river during late years. Hill's Bar, near Yale, ha probably afforded more gold than any other single locality on th Fraser. It was estimated to have produced in all, (to 1875,) not le than $2,000,000 worth of gold from a total area of less than half square mile. (Report of Minister of Mines of B. C., 1875, p. 17.) It position at the foot of the very rapid portion of the Fraser, where th river first frees itself from the cañon and expands to a greater widt with a slacker current, is a suggestive one in respect to the origi of its gold. Instances of the yield of other bars are given in con nexion with their enumeration on page 115 R, *et seq.*

Partial statement of value of gold derived from the Fraser River and some of its tributaries, approximately as included in the list of localities, pp. 115 R *to* 119 R, 1874 *to* 1888.

1874	$ 55,000
1875	50,000
1876	42,000
1877	37,000
1878	14,000
1879	54,000
1880	93,300
1881	75,184
1882	70,200
1883	73,000
1884	122,934
1885	123,700
1886	157,000
1887	120,000
1888 (partial, not including Lower Fraser)	90,160

The above table is derived from the returns in reports of the Minister of Mines of British Columbia. It is, unfortunately, very imperfect, even for the years which it professes to represent. It is more than usually difficult to obtain returns from the Chinese and Indians, in whose hands a large part of the work done here is. In addition, the returns for the several years are not strictly comparable, and do not in most cases include all the several localities referred to in the title. No returns appear to have been obtained from the Lillooet region in some years, and in others a portion of the upper part of the river is included in Cariboo district. I believe it would not be excessive to estimate the yield of the Fraser, including the Main Thompson River, Bridge River, and the Lillooet country at $100,000 per annum since 1860, which would give a total yield from that date to 1888, of about $2,900,000. Yield of the Fraser.

It scarcely I believe admits of doubt, that extensive and successful mining enterprises based on the application of the hydraulic method of working, will yet be instituted along a great part of the length of the Fraser valley, while dredging or other methods by which the materials of the bottom may be obtained and treated, may also be profitably employed. The great extent of the bench or terrace deposits of the valley, with the excellent opportunity of disposing of the waste, offer exceptionally favorable conditions for hydraulic work, and tributary streams with a sufficient quantity and head of water for mining purposes are not wanting. Future prospects of work.

Importance of recording observations on placers.

On a subsequent page, a list is given of the principal bars and dig gings which were formerly worked along the Fraser River. This lis is as complete as the available information permits, both in regard t the names and positions of the bars, and in respect to their yield an the quality of the gold. It may be objected, that as many of thes deposits have now ceased to be continuously worked, such a lis possesses merely a historical interest. This, however, is far from bein true. It is of importance, not only as a guide to the selection of local ities for hydraulic or other similar systematic work on a large scale but also as affording a clue to the places of origin of the gold, and i directing the search of the explorer who is in quest of paying deposit of gold in its original matrix.

'Coarse' and 'fine' gold.

It is unfortunate that so much of the practical information obtaine by the early miners is now irrecoverably lost, but an examination o that which I have been able to obtain is sufficient to lead to certai general conclusions. Nothing has been more certainly ascertained i connexion with placer-mining in general, than that the 'coarse' o 'heavy' gold, unless under very exceptional conditions, does not trave far from the place of its origin, even in very rapid streams. 'Scale or 'flour' gold may, however, be transported to great distances by river such as the Fraser, before it finds a final lodgment, or become reduced by attrition to invisible shreds.

Fine gold on the lower river.

The lowest bar on the Fraser which was found to yield remunerativ returns, was Maria Bar, about twenty-five miles below Hope, an nearly opposite the mouth of the Chilliwack River. Thence t Hope, and in the neighborhood of that place, all the gold found wa 'flour' gold, of great fineness. In ascending from Hope to Yale, how ever, it was observed that the bars became richer and the gold wa often not so fine. It is highly probable that all this gold was trans ported by the river itself, and that none of it has a local origin. Fro a point on the river a few miles below Boston Bar (or about sixteen mile above Yale) to Sisco Flat, a short way below Lytton, a distance i all of about twenty-five miles, rich deposits of 'heavy' gold wer worked. Further up the river is a second run of 'heavy' gold, th limits of which cannot now be so well defined, but which appears t have extended from a point about half way between Lytton and Foster' Bar, to some little distance above Fountain. Here nuggets of som size were occasionally unearthed, and there were some exceptionall rich diggings. On the Thompson, the vicinity of Nicoamen, where th original gold discovery occurred, has always been noted for its 'coarse gold.

Runs of coarse gold.

Connexion of coarse gold with rock-formations.

On comparing the portions of the Fraser River thus found to yiel 'coarse' gold with the rock formations of the country, it is found tha

the first described run of 'coarse' gold corresponds almost exactly with that portion of the valley which is excavated in certain schistose argillites and micaceous and other schists of dark colour to which the name of Anderson River series has been provisionally assigned. It must, however, further be remarked that a series of Cretaceous argillites, conglomerate and sandstones which have probably been deposited in a still earlier hollow excavated along the out-crop of the soft rocks of the Anderson River series, also runs parallel to this part of the river, on its east side; and that while it is probable that the gold has originally been derived from the Anderson Rivers eries, a portion of that now found in the river may have been obtained by the robbing of Cretaceous placers contained in these later rocks. This is rendered all the more probable, by the fact that the second run of 'coarse' gold again corresponds with a similar trough of Cretaceous rocks, in the bottom of which, though the occurrence of the Anderson River schists is known in some places, (as near Lillooet), these older rocks are not extensively exposed by the present river.

Coarse gold at Nicoamen.

Near Nicoamen, on the Thompson, the 'coarse' gold is found along a portion of the river which follows the junction of granitic rocks with the edge of a great thickness of Tertiary rocks, chiefly of volcanic origin. I have supposed that the gold may here occur in a disseminated form in some of the volcanic rocks or may possibly have been robbed from Tertiary placers occurring beneath the volcanic part of the series.

Guidance in search for gold-ores.

The 'coarse' gold is, in any case, on these rivers, distinctly in association with certain geological conditions which offer a fairly certain clue as to the rock-formations in which it should be sought for, either in the form of lodes, or in a disseminated state in certain beds. The precise location of exceptionally 'coarse' gold in certain bars and benches, making due allowance for a certain amount of movement down stream, should further give an indication of the actual localities in which the search for gold in its matrix may be engaged in with the greatest prospects of success.

Belt of gold-bearing rocks.

It may further be observed, that gold has been found on the Anderson River, on Lillooet River and on Bridge River, all nearly on the line of strike of the Anderson River series and the overlying Cretaceous rocks, in such a manner as to mark out pretty distinctly the course of an auriferous belt to the east of, and parallel with, the axis of the Coast Ranges.

Cariboo District.

The Cariboo district,* entered by the miners in 1860, has ever since produced the greater part of the gold of the Province. It has proved to be one of the best 'placer-mining camps' ever discovered, and though most of the heavy runs of gold on bed-rock, so far found, may now be considered as worked out, its capability as a field for placer-mining of one kind or other, is by no means exhausted, and the very limited area within which some of the richest finds have occurred, encourages the belief that no great difficulty will eventually be found in tracing these alluvial deposits to their sources.

Physical characters of the Cariboo district.

The fifty-third parallel of north latitude passes through the centre of the Cariboo mining district, which may be described as a mountainous region, but is perhaps rather to be regarded as the remnant of a great high-level plateau, with an average elevation of from 5000 to 5500 feet, dissected by innumerable streams which flow from it in every direction, but all eventually reach branches of the Fraser River. These streams, falling rapidly about their sources over rocky beds, descend into great V-shaped valleys, and, with the lessening slope, the rock becomes concealed by gravel deposits, which increase in thickness and extent till the valleys become U-shaped or flat bottomed, and little swampy glades are formed, through which the stream flows tortuously and with gentle current. The steep-sloping banks of the valleys are densely covered with coniferous forest, of which comparatively little has been destroyed by fire, owing to the dampness of the climate at this great altitude. The surface of the broken plateau above is often diversified by open tracts, affording good pasture in summer; and the whole country is more or less thickly covered by drift or detrital matter, concealing the greater part of the surface of the rocky substratum.

Progress of mining.

As in all new gold-mining districts, the shallower placer deposits, and gravels in the present stream-courses first attracted attention, but with the experience of California and Australia, it was not long before the 'deep-diggings' were found to be far the most profitable. Williams and Lightning creeks have, so far, yielded the greater part of the gold of Cariboo. They were known from the first to be rich, but have been found specially suited for deep work, in having a hard deposit of boulder-clay beneath the beds of the present water-courses, which prevents the access of much of the superficial water to the workings below.

Deep mining and old channels.

By regular mining operations, the rocky bottom of the valley is followed beneath fifty to 150 feet of overlying clays and gravels, the

* This term is here used in a restricted sense, being applied to the mining region, and not to the much more extensive electoral district of the same name.

course of the ancient stream being traceable by the polished rocks of its bed, and the coarse gravel and boulders which have filled its channel. In the hollow of the rocky channel the richest 'lead' of gold is usually found, but in following the rock-surface laterally, side-ground, rich enough to pay well, is generally discovered for a greater or less width. The old stream-courses of the Cariboo district are found to have pursued very much the same directions that their present representatives follow, crossing often from side to side of the valley with different flexures, and occasionally running through below a point of drift material projecting into the modern channel, but never, I believe, actually leaving the old valley or running across the modern drainage system, as is so often the case in the deep placers of California and Australia.

The most important deep work was carried out in the old pre glacial and buried channels of Williams and Lightning creeks, where it has now practically almost ceased. As the methods employed are, however, of interest in illustration of the mode of occurrence of the richer gold deposits, and may yet be applied to other valleys even in this district, the following description is included. It will serve as a general description of this class of mining, and is substantially the same with that given in the previous publication on the mines of British Columbia, and refers particularly to the work in progress at the time of my visit to Cariboo in 1876. Deep mining of Williams and Lightning Creeks

To reach the buried channel, on which it is generally impossible to sink directly through the superposed loose and watery materials, a shaft is usually sunk at the lower, or down-stream end of the claim, on the sloping side of the valley, where, after having gone through a moderate depth of clay or gravel, the slaty rock of the district is reached. The shaft is then continued through this, till a depth supposed to be sufficient is attained, when a drift is started at right angles to the course of the valley, and if the right depth has been chosen,—either by rough estimation, or calculation based on that required in other neighbouring workings—the old channel is struck in such a way as to enable the subterranean water collecting in it from the whole upper part of the claim, to be pumped to the surface by the shaft. On driving out of the slate rock, however, into the gravel, so much water is frequently met with that the pumps are mastered, rendering necessary a cessation of work till the latter part of the season, or the application of more powerful machinery. When the drift is not found to be at a sufficient depth to cut the bottom of the old channel, it is generally necessary to close it, and after continuing the shaft to a greater depth, to drive out again. The old channel once reached, and cleared of water, is followed up its slope by the workings, to the upper part of the claim, and where paying side-ground occurs this is also opened. Shaft-sinking. Drifting.

Fig. 1. Section across Lightning Creek valley at the lower end of Victoria Claim, shewing position of old channel, etc. From report by J. Evans, in Report of Minister of Mines of British Columbia, 1875. Approximate scale 120 feet to one inch.

Character of the buried deep channel.

The richest pay is generally obtained in the actual channel of the old stream, but where this is much contracted the force of the water is often found to have swept the gold away to those places where its width is greater. The harder rocks still preserve their polished and water-worn forms, but most of the slates are rotten and crumbling, to a considerable depth, and in cleaning up in the bottom, a thickness of one to two feet is frequently taken out with the pick and shovel, and sent up to the surface with the overlying gravel, for treatment. In the side-work, as in the central channel, the greater part of the gold is found lying directly on the 'bed-rock,' though, in some cases, particularly on Williams Creek, paying layers occur in the gravel several feet above it. The side-ground is worked up from the channel in successive breasts parallel to it.

Deposits of old channels.

The lowest layers of gravel generally contain many large boulders of quartz and slaty fragments not much water-worn, which must have come down from the hill-sides; the appearance being that of deposit by torrential waters to a depth of four to six feet in the channel, above which the gravel is generally better rounded, and more evenly spread, though still mixed with clayey matter.

Difficulties from water, etc.

In consequence of the unconsolidated nature of the gravel, the pressure on the supports of the workings is often excessive. The sets of timber are, in some places, only a few inches apart, and the whole of the workings have, in some cases, to be lined with complete lagging. The timber used is usually massive, being from one to two feet in average thickness, and consisting of the spruce of the country, simply barked and sawn into lengths. Its cost delivered at the mine at the date mentioned, was eight cents per running foot, all suitable sizes being taken at the same rate. The lagging, which is merely split out, four feet long, five inches wide, and two thick, cost seven dollars a hundred pieces. With every precaution, the timbers are frequently crushed by the pressure, or the uprights even forced downward into the slate.

Where large boulders are removed from the sides, or 'slum' is found, spruce brush requires to be extensively used behind the lagging, and in many places the water streams from the roof like a heavy shower of rain.

The whole of such deep workings were, as a rule, annually filled with water at the time of the spring floods, and it was sometimes not till late in the summer or autumn that the pumps again acquired the mastery. Flooding of workings.

The following are particulars referring to the Van Winkle mine on Lightning Creek, which was the most successful in operation at the time of my visit in 1876. Van Winkle mine.

The claim covered about 2050 feet in length of the valley, the deepest part of the old channel of which had been cleared out to a length of between 1600 to 1700 feet in October of 1876. Much side-ground, however, yet remained, and the workings sometimes attained a width of from 200 to 300 feet in following this up as far as it could be made to pay. The claim yielded the first dividend in December, 1873, $40,000 having been expended before gold was reached in the channel. It afterward paid handsomely, having produced in one week gold worth $15,700, and on other occasions at the weekly 'clean-up,' sums of $14,000, $12,000, etc. At the date above mentioned the total product of gold had amounted to the large sum of $500,965.

In the Van Winkle mine, the average depth of the workings was about seventy feet only, the lowest shaft being placed 300 feet from the stream, on the opposite side of which the rock rises to the surface, forming steep cliffs. The water was raised to within forty feet of the surface, when it was discharged into an adit 3000 feet long, which was also used by other claims. There were two pumps, ten inches in diameter, the power being supplied by an eighteen-foot breast-wheel. This did not, however, represent the total volume of water pumped, as the ground of this claim was partly drained by others lower in the series, in which work could not be carried on till late in the season. In October of 1876 the following companies on Lightning Creek were driving their pumps day and night, the Van Winkle being the only mine clear of water:— Water pumped.

Costello Claim.—Pump, twelve inches diameter, nine-foot stroke, making ten strokes a minute.

Vulcan Claim.—Pump, twelve inches diameter, six-foot stroke, making eighteen strokes a minute.

Vancouver Claim.—Pump, twelve inches diameter, nine-foot stroke, making ten strokes a minute (double acting).

Van Winkle Claim.—Pumps, ten inches diameter, fourteen-foot stroke, making ten strokes a minute (two pumps).

The quantity of water being raised at this time would, therefore, amount to about 13,870 gallons a minute, or 19,874,000 per diem.

In many cases the machinery and appointments used in mining on the deep channel were very creditable, and almost the whole of this work was paid for by the miners of the district itself. Money gained in one enterprise was usually invested in another, and the share-holders in a mine were frequently to be found themselves at work in it.

Length of working on deep channel.

On Lightning Creek, the old deep channel has been followed and worked out to a length of about 16,000 feet in all, and in addition a number of rich bench claims and tributary creeks have yielded good returns. In endeavoring to 'bottom' the old channel further down the valley, very great difficulty is encountered, in consequence of the quantity of water and the increased depth of the sinking required. The Eleven of England is the lowest claim in which the old channel has been reached, and though evidence was here found, in the finer character of the gold, of increasing distance from the main sources of supply, it is probable that still lower portions of the valley may be proved to pay, with improved facilities.

Yield of claims on Lightning Creek.

It is impossible to present complete returns of the amount of gold obtained from the old bed of Lightning Creek, but the following approximate statement to November 1st, 1875, published in the report of the Minister of Mines of British Columbia for 1875, is still of interest in showing how large this amount, in the aggregate, must have been. The claims are here arranged in their order following down the creek.—

Campbell and Whitehall	$200,000
Dutch and Siegel (now Perseverance)	130,000
Dunbar	30,000
Lightning	153,962
Discovery and Butcher	120,000
South Wales	141,531
Spruce	99,908
Point	136,625
Van Winkle	363,983
Victoria	451,642
Vancouver	274,190
Vulcan	56,955
Costello	20,476

It would probably not be an exaggeration to state that the deep channel, for the portion of its length above referred to, with the adjacent side ground worked at the same time, has yielded throughout gold to the value of over $200 to the running foot.

Williams Creek

On Williams Creek, on which the towns of Barkerville and Richfield are situated, the chief workings have been in a space of about two miles and three-quarter in length. In this the deep channel has been worked

through, and also as much of the side-ground as would pay at the time at which the mining took place. Many of the lateral creeks and gullies here have paid remarkably well; and the hill-sides, in some places to a height of a hundred feet or more, have proved to be sufficiently rich for the hydraulic method of working, which is now profitably carried on. Though Williams' Creek has produced in the aggregate the greatest amount of gold, Lightning Creek showed for a time a larger annual yield.

Ground above and below 'The Cañon.'

'The Cañon' between Barkerville and Richfield divides Williams Creek into two parts. For about half-a-mile above it, the ground was shallow, and has been worked open to the bed rock. Further up, deep drifting was practised in former years and hydraulic work is now carried on. Below 'The Cañon,' all the work has been deep, in the old channel. alhough 'pay streaks' were sometimes found after getting down about twenty feet, these were usually disregarded in early days. In the Cameron claim, however, half-a-mile below Barkerville, the dirt paid nearly to the surface, and was worked in stages from below after the old channel had been cleared out. The workings were about sixty feet deep at Barkerville, only thirty-five feet at the former site of Cameronton, and at the Ballarat claim,—three-fourths of a mile below Barkerville—eighty feet. This is one of the lowest claims in which the old channel has been bottomed, and most of the gold obtained was light and scaly. The valley is here wide, the present stream turning abruptly to the west, while a wide, low hollow, known as Pleasant Valley, runs off in the opposite direction, to Antler Creek. It is supposed by many, that the main channel of the ancient water-course turns off in this direction, but owing to the great quantity of water and loose character of the ground, neither this nor the present valley of Williams Creek below the Ballarat, has yet been proved, though much money has been expended in the attempt. The Lane and Kurtz Company went to great expense in importing machinery and erected very complete works some years ago, but did not succeed in proving their ground, and have since abandoned the attempt. The place at which this work was carried on is known as 'The Meadows,' the valley here opening out and becoming wide and flat-bottomed. The Company held a concession covering about four miles in length of the valley, but succeeded in reaching a depth of 125 feet only, and in drifting out found that they were still too high for the deep channel, while the volume of water was greater than their pumps could master.

Lower part of valley.

'The Meadows.'

Yield of various claims.

As shewing the great local accumulation of gold in the deep channel of Williams Creek, and indicating its local origin, the following approximate statement of the value of gold obtained in various claims, covering certain lengths of the channel, is important. All these claims

were below 'The Cañon,' but they do not form a consecutive series, r
such details being available for many other claims.—

Adams	100 feet.	$	50,000
Steele	80 "		120,000
Diller	50 "		240,000
Cunningham	500 "		270,000
Burns	80 "		140,000
Canadian	120 "		180,000
Neversweat	120 "		100,000
Moffat	50 "		90,000
Tinker	140 "		120,000
Watty	100 "		130,000
	1340 "		$1,440,000

Prospects for further work on Williams and Lightning Creeks.

In Cariboo district, even to the present time, the prices of labo
and supplies have never been lowered to a point at which it would
profitable to work any but the richer deposits, which in the nature
things bear a small proportion to those capable of yielding a modera
or small amount of gold; and in working over the deep ground in ear
days much was left that would even now pay handsomely, but cann
be found or reached on account of the treacherous nature of the mov
ground, filled with old timbering and water. On both Williams an
Lightning creeks, but particularly in the former, there must be a gre
quantity of gold in ground of medium richness even yet. To rend
this gold available, however, and to prove successfully the lower an
more difficult parts of the valleys, greater and more exact engineeri
knowledge, better and larger machinery, and, above all, cheaper labo
and supplies, dependent on greater facilities of transport, such as wou
result from railway connection, are required.

Bed-rock Drain and Flume.

The most important works of a general kind which have so far be
carried out in Cariboo district are the Bed-rock Drain and Bed-ro
Flume, on Williams Creek. The first of these is a tunnel which ru
through all the old deep workings, beginning at the lower end of t
part of the creek called 'The Cañon' (about 1000 feet above Bark
ville) and running out in 'The Meadows.' The total length of th
tunnel is about one and one-eighth mile, and the cost of its constru
tion is estimated at about $100,000. The Flume, constructed in 18
begins about 1000 feet above the head of the Drain, at the upper e
of 'The Cañon.' It is a cutting averaging about twenty feet in dep
and a mile in length, and is estimated to have cost about $250,0
Into it the small flumes of the various companies working along t
creek discharge, and it has also served for the working of the grou
belonging to the Flume Company. By means of the free drains

afforded by these works, a great part of the later mining has been rendered possible.

Possible flume to Antler Creek

As an illustration of what might be done in this way, it may be mentioned, that it has been suggested, that by cutting a flume to Antler Creek — part of which would require to be a tunnel — free drainage of the whole upper part of Williams Creek would be obtained, and if the grade should prove to be sufficient on survey, it would enable the valley from its sources to the flume level, with all its old workings, and the great depth of tailings holding more or less gold which has accumulated, to be completely stripped by extensive hydraulic works.

Unproved deep ground on other creeks.

In the above general notes on Cariboo district, Williams and Lightning creeks have been particularly referred to as exemplifying the conditions there found, and the methods employed in working the old deep channels. These two creeks have, besides, yielded by far the greater quantity of the gold, and on them the pre-glacial channels have been found to be continuous, and though deep, specially well adapted for working. Underground drifting on old channels has, however, been practised, as well as several other creeks, of which Keithly, Harvey, Grouse and Mosquito creeks may be specially mentioned. There are besides a number of creeks which have yielded much gold by surface work or in open sinkings of moderate depth, portions of which still remain, which it is confidently believed by miners would prove rich in deep ground if properly explored. Antler, Cunningham, and Jack-of-Clubs creeks with Willow River are supposed to be specially promising from this point of view, and though attempts have been made from time to time to test the deep ground on several of these, it has not yet been successfully accomplished. On Antler Creek, in particular, the Nason Company has been at work with this object for a number of years, and has not yet abandoned the efforts.

Gold yield of Cariboo district

Approximate statement of value of gold produced by Cariboo District, from 1874 to 1888. *

1874 (partial)	$ 700,000
1875	1,075,237 †
1876	646,000
1877	411,402
1878	380,535
1879	500,000
1880	564,000
1881	610,737
1882	471,525

* From the Reports of the Minister of Mines of British Columbia.

† Possibly too high. Lighting Creek was, however, yielding well in this year, and was estimated to have produced $500 000 of this amount.

1883	457,767
1884	423,855
1885	347,700
1886	288,300
1887	247,673
1888	250,377

Remarks on yield.

The amounts above assigned to the various years are merely app imate, particularly for the earlier years of the series, the return which are extremely imperfect. The table as a whole, however, trates the large amount continuously afforded by the Cariboo dis from a period beginning more than ten years subsequent to its covery and after the most productive years had passed. It also dences the gradual falling off in yield, which has been nearly con ous since the richer portions of the deep channel of Lightning C has been worked over.

Similkameen, Rock Creek and Okanagan.

Having given in the preceding pages a somewhat full outline o general mode of occurrence and working of the gold-placers of Car which are the most important in the Province, the remaining pl mining regions must be very briefly noted, reference being made such special particulars as appear to be of interest to the list of lo ties on subsequent pages. The general features of the various distr though here given in connexion with placer-mining, may also be r red to in connexion with vein-mining in the same localities.

Physical characteristics.

The Similkameen, Rock Creek and Okanagan region includes son the first discoveries of gold in British Columbia, and has never been entirely abandoned, though the amount of work carried on fluctuated from year to year. This region stretches across the interi the Province, and includes on one side streams rising in the inner fl of the Coast Ranges; on the other, valleys which penetrate western edge of the elevation of the Gold Ranges. The phy characteristics met with in this wide stretch of country are varied, including mountains and plateau country with exte wooded tracts penetrated with difficulty, but also some of the lo warmest and most arid valleys of the Province, like that of the S kameen itself. The most notable portions of the region in respe the occurrence of 'coarse' gold, of evidently local origin, are Gr Creek and Tulameen, Rock Creek and vicinity, Cherry Creek Mission Creek. Elsewhere the gold is generally 'fine,' and is ch obtained from river-bars and flats, or from low benches. The mos teresting features in the region are, the late resumption of gold mi

Localities of coarse gold.

on a somewhat extensive scale on the Tulameen, the recent discovery (in 1885) of rich deposits of 'coarse' gold on Granite Creek, an inconspicuous stream, passed by hundreds of prospectors in early years; the transference of attention from the more or less completely exhausted placers of Rock Creek and Cherry Creek to the development of veins containing the precious metals, in the same vicinity, and the occurrence in very considerable quantities throughout the Similkameen district of platinum, alloyed with other related metals. On these points, further details are given elsewhere. It may be added here, that no part of this region is now so remote from means of communication as to cause serious difficulty in the development of any really rich metalliferous deposits, and the adoption, where circumstances warrant, of improved methods of placer-mining on a large scale.

Features of interest.

Platinum.

No reasonably complete returns of the annual gold yield of the region here spoken of exist, in consequence of the desultory character of most of the mining, and the various channels by which the gold obtained found its way out of the country. Since the resumption of activity on the Upper Similkameen, consequent on the discovery of Granite Creek, the returns for that part of the region are given as below, in the reports of the Minister of Mines of British Columbia. Of the entire yield stated, Granite Creek itself has contributed $383,000.—

Gold yield.

1885	117,500
1886	203,000
1887	128,000
1888	105,000
Total	553,500

Kootanie and Big Bend.

Disregarding numerous less important and scattered localities of gold-mining, the remaining districts which have acquired celebrity from this point of view, align themselves, with that of Cariboo, on that member of the Cordillera system, which has been described under the name of the Gold Range. The Kootanie region, including under that general term the somewhat distinctly separated Big Bend country, extends from the International boundary north-westerly to the Great Bend of the Columbia, with a length of 246 miles. It is, for purposes of description, also regarded as including the adjacent western slopes of the Rocky Mountains proper. Wild Horse, Perry, French, McCullough and Carnes creeks may be mentioned as the most productive, though there are also many less noted localities, and a great number of streams which have as yet been little, if at all prospected, though

Principal localities of mining.

favourable in appearance. The mines of Wild Horse Creek have proved the richest in this region, though confined to about two miles in length along the valley of that stream. They were developed early in the history of gold-mining, and have ever since produced a considerable annual yield. Nearly all the other streams which enter the Columbia-Kootanie valley are known to hold more or less gold, and river-bars have been successfully worked along the Columbia and in places on the Kootanie. The discovery within the last few years of paying ground on Porcupine, Cañon and Quartz creeks, shows that the possibilities of this region for placer work are as yet by no means exhausted, and the resumption of work on Carnes, French and McCullough creeks, since the opening up of the country by the railway, bears similar evidence.

Physical characteristics.

With the exception of some considerable tracts of fertile and partly open country along the lower valleys, the greater part of this region is extremely mountainous. It is generally well wooded, often bearing fine timber, but it is penetrated with difficulty, and much yet remains to be done in the way of prospecting before it can be considered to have been even fairly run over in search of placer mines. There is good evidence, in several places, of the existence of rich, deep ground in the valleys of creeks partly worked in former years, and some attention is also being paid to the initiation of hydraulic work on a considerable scale. The climate in the lower valleys enables a prolonged working season to be obtained on the placers. The rough character of the country, with the circumstance that neither the Columbia nor the Kootanie is continuously navigable, renders many parts of the region very difficult of access, and up to the time of the opening of the Canadian Pacific Railway, communication with it was almost entirely maintained from the south, a comparatively small portion of the gold yield finding its way to the banks in Victoria, and therefore not appearing in the returns, though it may be supposed to be covered by the amount allowed for as not recorded. The recent developments of vein-mining in this region are elsewhere alluded to.

Gold yield of Kootanie district.

The gold-yield from 1874 to 1888 from the Kootanie district (nominally including also the Big Bend country, though except in the later years covered by the return, no mining of consequence was actually in progress there) is given by the Minister of Mines of British Columbia, as below.—

1874	$50,000
1875	41,890
1876	25,000
1877	37,000
1878	25,400

1879	19,000
1880	19,500
1881	25,000
1882	29,500
1883	29,100
1884	60,826
1885	76,650
1886	58,500
1887	37,900
1888	47,612

Omenica District.

Next in order, on the line of the auriferous axis of the Province, and separated from the last-mentioned region by a considerable interval in which no important gold-mining has yet occurred, is the Cariboo district, previously described.

Physical characteristics.

Still further to the north-westward along the same belt, beyond an interval in which the Gold Range can scarcely be traced, is the Omenica district, first entered about 1864, but scarcely developed till 1867. This district is situated near the 56th parallel of latitude and is in the drainage-basin of Peace River. The area within which the greater part of the mining has taken place is scarcely more than fifty miles in greatest diameter, and includes the upper portions of Germansen, Omenica and Mansen rivers and their tributaries. This area is described as being hilly rather than mountainous, and is nearly everywhere covered by the dense northern forest. A very high opinion was at first formed by miners of the Omenica district, but when the Cassiar discoveries occurred, it was nearly abandoned. In 1879, it was re-occupied by about fifty-seven Whites and twenty Chinese, and Vital, Germansen, Mansen, Black Jack (a tributary of the last) Slate and Lost creeks were being worked; but the richer known localities having been since worked over, the mining has gradually dwindled to very small proportions. In 1887, only twelve Whites and about eighteen Indians are known to have been at work, and the gold produced is estimated at $13,000. Much 'coarse' gold was obtained, but the diggings were generally complained of as being 'spotted' or irregular. This district is practically the most remote and inaccessible in the Province, the cost of supplies has always been excessive, and the difficulties in the way of enterprise in the form of exploration thus very great. A wide area of promising country in this region, therefore, remains untried. The head-waters of Finlay River have always been considered particularly promising, from the fact that good 'prospects' of fine gold are found in all the river-bars, some of which have paid well for work

Mining.

Little 'prospected' region.

on them. The sources of the Nation River have also been favoura spoken of, and the Misinchinca and other tributaries of the Pars present all the appearance of gold-bearing streams, but so far as I kn have never been tested. The 'fine' gold which is found and has b mined along the whole upper portion of the Peace River, has dou less been carried through the mountains by that stream, and is deri from the wide belt of dark, shaly and schistose rocks which runs alo the western flanks of the Rocky Mountains in this portion of th length.

Arquerite or silver amalgam. Considerable quantities of arquerite, a silver amalgam contain about eleven per cent. of mercury, have been found with the g in scales and nuggets, in Omenica, particularly upon Vital and Sil Creeks. This metal is commonly referred to by the miners as 'silv with which its appearance is identical (see p. 73 R). Very prom ing deposits of highly argentiferous galena have been found in vicinity of the placer mines in Omenica, but no attempt has so far b made to work them. (See p. 73 R).

Routes to Omenica. The miners reached Omenica by two principal routes, viz., w pack-animals, by trail from Quesnel *via* Stuart Lake, and on f across the Babine and Fire-pan Mountains from the Forks of Skeena, the Forks being attained in the first place by ascend the Skeena from the coast in canoes.

Gold yield of Omenica. The gold-yield for the first and more prolific years of the Omen district cannot be ascertained with any completeness, and even si the commencement of the annual government reports, a gap of th years occurs, no returns being given for 1876, 1877 and 1878. Dur these years, however, the field was virtually almost deserted. T following table is based on the government reports.—

1874	$38,000
1875	32,040
1876	no return.
1877	"
1878	"
1879	36,000
1880	45,800
1881	39,300
1882	25,330
1883	21,000
1884	12,000
1885	16,500
1886	17,600
1887	13,000
1888	no return.

Cassiar.

The Cassiar district, includes the most northern region of gold-mining in British Columbia, and some of the creeks which have been worked lie to the north of the 60th parallel, or northern boundary of the Province. Dease Lake, lat. 58° 30', long. 130° may be considered as the central point of the district. This lake is the source of the river of the same name, which is a tributary of the Liard, itself a branch of the Mackenzie. Gold had already been found and worked on the river-bars of the Stikine for eleven years, when Thibert and McCullough, coming from the east, reached and discovered the richer deposits of the Liard drainage-basin in 1872. The miners, who soon flocked into the district, came by way of the Stikine River, though a route for cattle and pack-animals was also opened overland from Fraser Lake. Dease, Thibert and McDame creeks and their tributaries have proved the richest, and a large quantity of gold has been obtained from them; though the yield has, of late years, become comparatively inconsiderable. The region presenting identical or analogous characters with that portion of it which has proved to contain these rich deposits, is very extensive, and much the same remarks which have been made in regard to the exploration of the Omenica district apply here also, though the cost of living in Cassiar has usually been somewhat more moderate. The country is generally wooded and mountainous, and difficult to traverse, but a waggon-road or even a railway, might without difficulty be constructed from the head of navigation on the Stikine to Dease Lake, and this will no doubt eventually be accomplished, as discoveries of veins containing the precious metals are confidently to be anticipated. Argentiferous galena has already been found, and the rough, unworn character of the gold on some of the creeks leads to the belief that its source might be ascertained without great difficulty. 'Coarse' gold is found locally on that part of the Stikine above Telegraph Creek, and the circumstances appear to indicate the existence there of an old channel, above the present river-level, but covered by massive flows of basalt of Tertiary age. (see p. 47 B.)

Chief localities of mining.

Region to be 'prospected.'

Difficulties have been encountered in this district from permanently frozen soil met with in mining, but when once the covering of forest and moss had been cleared off by fire these disappeared.*

Frozen soil.

The gold yield of the Cassiar District, from the commencement of mining to the present date, so far as known, is shewn in the following table, which, however, gives no returns for the earlier years of mining, when work was confined to the Stikine River.—

Gold yield of Cassiar.

* For further particulars on the Cassiar Region see Annual Report Geol. Survey, 1887. Part B.

1873	Not known.
1874	$1,000,000
1875	830,000
1876	556,474
1877	499,830
1878	519,720
1879	405,200
1880	297,850
1881	198,900
1882	182,800
1883	119,000
1884	101,600
1885	50,600
1886	63,610
1887	60,485
1888	43,325
Total	4,929,394

Yukon District.

This extensive region, situated to the north of the 60th parallel, and west of the main range of the Rocky Mountains, lies beyond the northern boundary of British Columbia, but in the continuation of the same metalliferous Cordillera belt, and is therefore naturally included in connexion with the Province. Gold-mining began here only in 1880, and so far has been chiefly confined to river-bar work, nearly all the long streams tributary to the Yukon having proved to yield more or less 'fine' gold. The aggregate length of rivers upon which gold has already been found is almost unprecedented, and the field for prospecting in search of richer deposits of 'coarse' gold is very extensive. So far the only discovery and mining of 'coarse' gold has been upon Forty-mile Creek, in lat. 64° 30'. The country is wooded and in general not extremely mountainous, and the rivers afford a means of travel in summer, though usually swift. Access to the country is, however, difficult, being generally obtained by way of the Chilkoot Pass which crosses the continuation of the Coast Ranges at the head of Lynn Canal.*

Great length of auriferous rivers.

Skeena River.

Gold yield of Skeena.

On the Skeena River, which reaches the Pacific near the northern end of the coast-line of British Columbia, placer-mining has been carried on to a limited extent during the past few years. Lorne Creek is the most important auriferous locality, but gold has been found in

* For further particulars on this region see Annual Report Geol. Survey, 1887, Part B.

several other creeks and gulches in the same vicinity. These are easily reached by canoe from the coast. The yield of gold, chiefly from Lorne Creek, is reported as follows.—

1884	$17,000
1885	18,000
1886	13,400
1887	5,280
1888	no return.

Vancouver Island.

In Vancouver Island, the only placer mining district of importance which has been worked, is that of Leech River, some particulars relating to which will be found on page 141 R.

General Considerations Respecting Placer Gold-Mining.

Future of placer-mining.

Though the yield of the gold-placers of British Columbia is now very much less than it was at one time, and shows at present a gradual decrease, placer-mining still contributes substantially toward the prosperity of the Province, and employs a considerable number of men. It is, moreover, to be anticipated that this form of mining may continue to be a feature in the industries of the Province for many years to come, and it is quite possible that circumstances may occur which shall bring about a notable revival of mining of this kind. Elsewhere it is commonly observed that placer-mining has been the first step toward vein-mining, not alone indirectly from the fact that the placer work has drawn a population to the metalliferous regions, but also directly by the actual tracing up of the gold first found in the alluviums to its original matrix. We cannot therefore afford to set this class of mining aside as a dead issue.

The future of placer-mining deserves consideration, particularly from the following points of view :—

Respective areas of rich and poor ground.

1. In each proved auriferous district, the poorer or less concentrated gold-bearing ground must necessarily greatly surpass in area that of the very rich deposits which alone pay for work with primitive appliances and with the cost of supplies and labour at high figures. Thus the cheapening of these essentials, produced by improved means of communication and by the settlement of the country, coupled with the attendant facilities for bringing heavier machinery and appliances into use, will enable the profitable working of greatly extended areas. These considerations apply particularly at the present time to the region of country in the vicinity of the railway or connected with it by

easily travelled routes. By the construction of the railway a large part of the Kootanie district, together with that bordering upon the lower part of the Fraser, has been opened up for work of this kind, and deserve particular attention. The hydraulic method of mining will doubtless rank first among the means to be brought into use for the utilization of the poorer deposits. From this point of view, the railway has also, to some extent, changed the conditions in the Similkameen and Rock Creek country, and in the Cariboo district. It has effected no change in regard to the Cassiar district, but as already noted, this district may, without great cost, be rendered easily approachable from the coast. The difficulties remain greatest with respect to the Omenica district, and a number of outlying places of less importance.

Further prosecution of placer-mining in known localities.

2. Another point deserving consideration, is the further exploration of the already known rich deposits of gold confined principally to the old buried channels of the streams. In reviewing the experience already obtained in working these, we notice, in a majority of cases, that it has so far been found possible to work lengths of from one to three miles of these old channels only, and while, in some instances, it appears that the rich ground is not more extensive, in many there is good reason to believe that much more remains, capable of yielding good returns, but which it has been found impossible to get at with the appliances and means at command. There are also quite a number of valleys in which, though the bed of the present stream has proved rich, the deep ground or old channel has not even yet been reached, or if reached, has not been satisfactorily tested. In all these cases it requires only more effective machinery and greater engineering skill to be brought to bear, to attain and work the deposits referred to, and it is likely that many of them will pay well when such means can be applied at a reasonable cost. It is not improbable, for instance, that thus treated, such localities as Williams Lightning, Cunningham and Antler creeks in Cariboo might be found to yield great additional amounts of gold, and whenever railway communication is provided for the Cariboo district, they will at least be thoroughly tested. Other methods involving extensive works with the same object, such as the damming or diversion of streams, and the construction of long, bed-rock flumes or drainage adits, fall under the same head, and there can be no doubt that extensive works of this character will eventually be undertaken in the Province with satisfactory results.

New discoveries.

3. The discovery of important new gold-bearing creeks is still to be anticipated from time to time. The small portions of the lengths of individual streams which have been found to contain great quantities of gold, is alone sufficient to show how easily such localities may be

missed or passed over in a rough mountainous country of great extent. Granite Creek and Cayoosh Creek afford definite cases of this kind, the first discovered only in 1885, the second in 1886, and both in parts of the country which have been more or less thoroughly over-run by armies of prospectors for the past twenty-five years. The tracts which have been slightly or scarcely at all examined, even those situated on the line of the auriferous range, are very extensive, and in the Yukon district, to the north of British Columbia, the prospects for discovery of this kind appear to be most favourable, and are still almost limitless.

4. Not the least important consideration, however, from the point of view of placer-mining, is that of the probable existence of placer deposits differing in age and character from those which have so far been worked in the Province. The rich deep leads of Cariboo evidently date from a period antecedent to that in which the country was for a time covered by a great ice-mass, or are, in other words, pre-glacial, and lie beneath the boulder-clay and other deposits due to the 'ice age.' The wearing down of the country-rock and natural concentration of gold had been in progress from the close of the Miocene or Middle Tertiary period (or perhaps in some localities even from an earlier date) to the glacial period. During the period of the Middle Tertiary, a great part of the Province included between the Coast Ranges and Gold Range became occupied by fresh-water lakes. These covered and by degrees filled up with their fine sediments, whole systems of drainage which had been produced during early Tertiary time; and into the lakes themselves, during the period of their existence, streams from the surrounding mountain regions discharged, forming gravel-beds, which are particularly abundant at the base of the finer deposits. Toward the close of the Middle Tertiary, extensive volcanic action occurred, producing the basalts and other igneous rocks which still overlie the greater part of the area of the old Tertiary lakes. Denudation which has gone on since this time, has locally removed considerable portions of these Middle Tertiary deposits, and has cut new valleys in them, and there

Probable existence of older placers.

Character of Tertiary deposits and Tertiary placers.

Modern placers

Fig. 2. Section on the Stikine River, above Telegraph Creek, shewing basalts filling a pre-Miocene valley and overlying the old river-gravels. From Annual Report Geol. Surv. Can., 1887, p. 71 B.

is reason to believe that some of the modern placer deposits have been enriched more by the robbing of these old, early and Middle Tertiary gravels than directly from the wearing down of the original rocks.

Places where ancient placers may be found.

Whenever, therefore, these old Tertiary gravel-beds or conglomerates exist in the vicinity of the known auriferous districts, they well deserve careful examination, though, so far as I am aware, none of them have actually been worked as yet in the Province. In such localities for example as Mission Creek, the South Similkameen and Whip-saw Creek, recent auriferous gravels rest upon the worn surface of Middle Tertiary rocks, consisting of soft argillites, shales and sandstones. These rocks are generally known to the miners as 'false bed-rock,' and it is highly probable that if they were sunk through to the bottoms of the still older valleys in which they lie, rich gold-bearing gravels or conglomerates might be found.

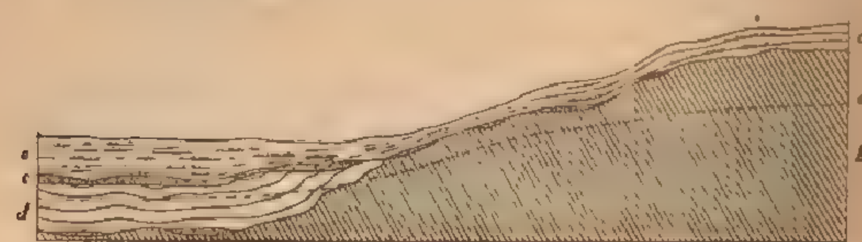

Fig. 3. Diagram representing mode of occurrence of gold on Mission Creek. *a.* Recent gravels. *b.* Crystalline rocks. *c.* Auriferous gravel. *d.* Tertiary beds, shewing the possible occurrence of underlying Tertiary placer-deposits. *e.* Line representing present bed of stream. From Report of Progress, Geol. Surv. Can., 1877-78, p. 157 B.

Mission Creek.

The accompanying section, reprinted from my report of 1877-78, illustrates the known mode of occurrence of gold on Mission Creek and the possible existence of old Tertiary gravels in that vicinity.

Probability of Cretaceous placers.

It is further probable that gravels dating from periods still earlier than the Tertiary, and now consolidated into conglomerates of varying degrees of induration, may be found to contain gold in remunerative quantity. Allusion has already been made in this connexion to the Cretaceous conglomerates of the Lower Fraser (p. 29 B), and similar conglomerates are also known to occur in great mass near Tatlayoco Lake and the head-waters of Bridge River, on the Quesnel River, and elsewhere. It may in fact be affirmed, that all gravel-beds or conglomerates of whatever age, occurring in or near the auriferous regions, are worth examination for gold, and particularly so when they are found directly in contact with the surface of the still older rocks which constituted the 'bed-rock' at the time of their formation.

Relation of places of different periods to physical features.

The gravels and conglomerate deposits of the Middle Tertiary, often bear a distinct relation to the modern valleys in the more mountainous districts, in which the main outlines of erosion have been nearly constant from a very early period, but in the wider and lower parts of the Interior Plateau, great areas are covered by nearly horizontal flows of basalt, beneath which, should old auriferous stream-beds exist, they can only be traced by underground work or by boring, in the manner adopted at Ballarat and elsewhere in Australia and in some places in California. Since the period of deposition of the still older Cretaceous conglomerates, the surface of the country has suffered so many changes, including among others the elevation of the Coast Ranges, that these conglomerates now bear little or no relation to the present drainage systems.

Instances of ancient placer deposits.

The considerations above stated are not merely of a theoretical character, but are warranted by experience gained in other regions. The old buried placers of California (which Prof. Whitney believes to have been in process of formation by erosion continued throughout nearly the entire Tertiary peiod), and those of Australia, are so well known to most gold-miners as to require no more than mention. It is not so generally known, however, that conglomerates of Carboniferous and of Carbonifero-Permian age have been worked for gold in New-South-Wales, and in Queensland (as at Peak Downs) and that gold in greater or less quantity has been found in conglomerates of the Carboniferous period in Nova Scotia (at Gay's River), and in France. Of still greater interest, in the same connexion, is the existence of gold in the Potsdam conglomerates of the Black Hills in Dakota, where these rest upon the surface of certain still older schistose rocks which contain auriferous quartz-veins. Regular mining operations have been conducted in these conglomerates, and they have been found to be, locally, extremely rich. Mr. Jenny states that there are four distinct ages of

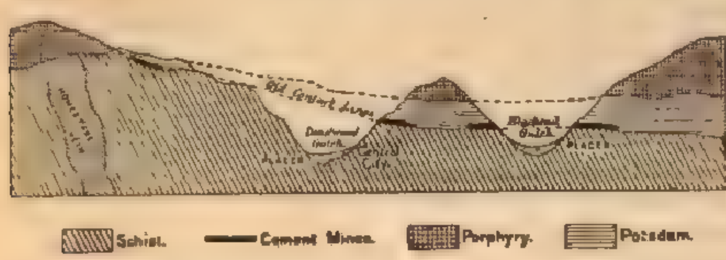

Fig. 4. Section in the Black Hills, Dakota, shewing the mode of occurrence there of ancient gold-placers in conglomerates at the base of the Potsdam sandstones, and the manner in which these have served as a source of supply of gold for newer placer-deposits in valleys subsequently formed by erosion. From paper by W. B. Devereux in Trans. Am. Assn. Mining Engineers, Vol. X, p. 468.

gravel formations in the Black Hills:—(1.) Potsdam, (2.) close of Tertiary, (3.) close of Glacial period, (4.) recent, and that all of these have proved to be auriferous, except the third. The accompanying section will illustrate the mode of occurrence of the 'fossil placers' of the Potsdam in the Black Hills, and the formation of recent placers secondarily from these, better than any description.

The auriferous Potsdam conglomerates are very compact, and require to be milled and treated like auriferous quartz, and the same may be said with respect to some of the old conglomerates or 'cements' of Victoria and of New Zealand. Some of those in Victoria are, however, stated to have yielded an average of twelve ounces of gold to the ton.*

Connexion of Placer-Mining and Vein-Mining.

Intimate relation of placers and gold-ores.

The transition from placer-mining to 'quartz-mining' is an easy one. The richer and more easily reached placers are, as a rule, soon worked over, and it then becomes natural to enquire as to the sources of these old concentrations. The consequent change of the centre of interest has already occurred in most parts of California and in Australia, but British Columbia is still in the transition stage in respect to gold mining. Save in a few exceptional cases, the occurrence of 'coarse' or 'heavy' gold in the old channels, may safely be accepted as proving that the original source of the gold is not far off. The distance to which 'coarse' gold travels is, as a rule, very inconsiderable, even in the beds of rapid streams. Additional evidence to the same effect is generally afforded by the varying assay value of the gold found on different creeks or even on different parts of the same creek, and this is often emphasized by the rough unworn character of the gold and the circumstance that it not unfrequently still holds imbedded fragments of quartz. It is from this point of view in particular, that it is most important to note and preserve a record of the observations made by the placer-miners in the course of their work, even where the deposits do not any longer continue to be remunerative.

Conditions in California.

Speaking of broad areas in California and Australia, where work of both kinds is in progress, it may be affirmed that the rich placer districts coincide with the rich quartz districts throughout. Innumerable special cases might be cited, if it were necessary, to shew the exceptionally rich local deposits of placer-gold depend on the occurrence of notably rich quartz-veins in immediate and clear relation to them, and in the fact that extremely rich localized placers have been found

* See, in this connexion, Ore Deposits, J. A. Phillips, pp. 232, 459, 508, 602; Mineral Wealth of Queensland, 1888, p. 25; American Inst. of Mining Engineers, vol. x, p. 466; U. S. Tenth Census, vol. xiii, p. 90.

in many parts of British Columbia, and particularly in the Cariboo district, we find justification for the belief in the future of 'quartz-mining.' It is true, that in some instances the natural concentration of the gold derived from the wearing away of a great mass of comparatively poor rock, may give rise to rich placer deposits, or that the veins from which the gold has been derived may be too irregular in richness, or too much broken, to be profitably worked themselves; but those exceptions cannot be regarded as negativing the general rule. The fact remains that a large proportion of the mines of precious metals in California and in Australia have been discovered by tracing the placer deposits of gold to their sources. Placer deposits derived from the Comstock lode were worked for ten years before the lode itself was discovered, and when found and opened, it proved to be essentially a great silver mine in which gold occurred in relatively small quantity. In the same way, the working of placer deposits preceded the discovery of the now celebrated Treadwell mine in Alaska, and the 'prospector' is justified in following up this clue wherever he can find it.

Placer deposits indicative of auriferous quartz.

General Remarks on Vein-Mining.—(*Precious Metals.*)

Gold.

The conditions of occurrence of workable auriferous lodes in British Columbia, yet remain to be studied in detail and discovered as the development of mining of this kind progresses. It may, however, be stated from what is already known, that while not confined to rocks of this class, the more important gold occurrences are usually found in connexion with areas of argillite-shales and schists, commonly of dark colours, and often more or less distinctly carbonaceous. Further, that only in certain parts of the extent of these argillite rocks have really rich placer deposits been found, a fact depending apparently on the occurrence locally of quartz-veins traversing them, and also, possibly, on the existence of igneous intrusions or other peculiar circumstances, which remain to be ascertained. So far as these generalizations go, they correspond with those already arrived at in California, saving that in British Columbia the argillaceous and schistose belts referred to, appear to belong to several geological horizons widely separated in date of formation, as already noted. The accessory local causes which have resulted in the deposit of gold in veins, etc., appear to be found most frequently in and near the Gold Ranges.

Occurrence of gold in British Columbia.

Comparison with California

While it is not possible here, even if it were necessary, to enter into any general discussion of the features and principles of the mining and treatment of ores of the precious metals, it may be useful to those now

interested in the discovery and development of such deposits in th Province, to note very briefly a few important points bearing on thi subject and dependent on recent investigations.

Tendency of recent mining.

As showing the general tendency of recent mining, and for the pu pose of directing attention to the larger deposits of low-grade ores, can not do better than quote the following judicious remarks of M Clarence King, who writes:—"It may be said that the richer and pure ores which were sought for in the early days of mining, have bee gradually giving way to those of more complicated nature and gene ally of lower value in the precious metals. Consequently in the r duction processes we find smelting acquiring a relatively more im portant place than it formerly held, and in milling an increasing use o dry crushing processes connected with subsequent roasting of the ore and a marked growth of the lixiviation process."*

Low grade gold-ores.

A particular instance of the treatment of low grade gold-ore occur ring in great mass, of special interest to British Columbia on accoun of its proximity, is afforded by the Treadwell mine in Alaska; th profitable working of which, upon a large scale, is rendered possible onl by the great advance in modern appliances and methods of treatment Further important evidence to the same effect is afforded by the result of recent mining in Australia and in the United States. From th

Australia.

Government Mineral Statistics of Victoria for 1887,† we learn that th average yield per ton in that year was 9 dwt. 9·95 grains only of gold (0·471 oz.) the quantity of quartz treated being 780,733 tons, whil the Ballarat district, one of the most important, yielded an average o only 7 dwt. 23·57 grains (0·399 oz.). Since the first publication o mineral statistics in Victoria, particulars have been obtained respect ing 23,386,935 tons of quartz, the yield of gold from which averaged 10 dwt. 11·09 grains (0·523 oz.). The cost per ton for crushing alone varied, in 1887, from 15s. to 4s. 6d.

California.

In certain localities in California, where the ore can be quarried rather than mined, under specially favourable circumstances, gold-bearing quartz yielding as little as $1 to the ton is reported to have been profitably worked.

For the purpose of further illustrating the class of gold-ores which may be worked with profit, the following tabular statement representing certain well known and largely productive mines in California and in the

Dakota.

Black Hills of Dakota, has been compiled. The first four mines yield free-milling ores, the last a sulphuret ore with only a certain proportion of free gold.‡ The figures for the two first mines and the fourth refer to the year 1885. Those for the third to 1884-85, and those for the fifth represent the average work for four years, 1881-84.

* U. S. Tenth Census. vol. xiii., p. xii.
† Mineral Statistics of Victoria for the year 1887. These figures refer to the ton of 2,240 lbs.
‡ See Hamilton Smith in Mining Journal, London. 1885, vol. lvi, part 2, p. 857, and T. G. Caruing, in Engineering and Mining Journal, N.Y., 1886, vol. xlii, p. 419.

MINE.	Quantity of ore treated.	Mining.	Milling.	Management, etc.	Total cost.	Total yield.	Profit.
	Tons.	$	$	$	$	$	$
Sierra Buttes, Cal.	54,479	4.06	0.56	1.21	5.83	6.98	1.15
Plumas Eureka, Cal.	56,052	4.36	0.61	0.60	5.57	7.60	2.03
Homestake, Dak.	213,190	Total cost per ton, mining, milling, etc..			3.25	5.73	2.45
Father de Smet, Dak	106,855	"	"	" ..	2.12	3.57	1.45
Idaho Mine, Grass Val., Cal.	....	Average cost of mining, milling, etc....			8.97	18.59	9.62

Gold-ores of various kinds other than 'quartz.'

It is of great interest further to observe, as the result of discoveries and investigations made within the last few years, that in endeavouring to trace out the sources of placer-gold and discover workable gold-ores, attention should not be too exclusively given to quartz-veins alone. While the greater part of the known gold-ores belong to the class of quartz-veins, it is now found that gold occurs also in payable quantity in many other associations.

Peculiar occurrences of gold. Queensland.

It has long been recognized that certain belts of rocks containing numerous small and irregular quartz stringers only, will pay for mining and crushing as a whole, and where, as in Cariboo, there is reason to believe that the larger known veins can scarcely be looked upon as the true sources of the 'coarse' gold of the placers, such quartzose belts of country-rock may well be sought for and tested. In Queensland, Victoria and New-South-Wales, Mr. Daintree and others have been able to prove, not only that there is an association between the paying quartz-veins and the vicinity of the occurrence of certain intrusive igneous rocks, but also that in these intrusive rocks and notably in certain pyritous diorites, gold occurs in some instances in such quantity as to have produced paying placers by their decomposition. Similarly, in Colorado, between South Park and Blue River, Prof. J. J. Stephenson describes certain dykes of compact trachyte and Silurian and Carboniferous quartzites as the sources of the placer gold which has been extensively worked there, though not themselves containing gold in payable quantity.

Colorado.

North Carolina.

In further evidence of the wide distribution of gold, it may be added, that in North Carolina, Prof. W. C. Kerr notes the following rocks as being there auriferous. In Morse County, a mine which yields its gold mainly from felspathic schist. In the famous King's Mountain mine the gold is obtained not only from certain seams of quartz, but also from a sixty-foot bed of schistose limestone, which is quarried out bodily and sent to the stamps. Gold is also found in paying quantities in quartzite-schist and quartz-slate, and in "grey much jointed quartzites and felsites of the Huronian hills on the eastern side of the

great slate belt" of North Carolina. From these facts Prof. Kerr is led to conclude that, "gold is so widely diffused that we may expect to find it in any kind of rock."

Mount Morgan deposits.

The Mount Morgan gold deposit of Queensland, which is the most important recently discovered, illustrates still another peculiar occurrence of exceptionally rich gold-ore. The gold is here found minutely disseminated in a mass of brown and red hæmatite and siliceous sinter, which has apparently been produced by a former thermal and geyser-like spring. The gold-content of this material is no less than about seven ounces to the ton and at present 1500 tons a week are treated. Fragments of richly auriferous rock resembling that of Mount Morgan have been found at Clinton, in British Columbia, but have not yet been traced to their source.

Treadwell Mine, Alaska.

I am not aware that any systematic description has yet been published of the Treadwell mine of Douglas Island, Alaska, but from an examination of it which I was able to make in 1887, I may say that the rock there worked appears to be nothing more than an upper part or edge of a great granitic dyke or intrusion, which has broken through the black, slaty argillites of the region, and has been subjected to extensive hydrothermal action, produced either by emanations from the granite mass itself, consequent on its relief from pressure on approaching the surface, or subsequently to the intrusion of the granitoid rock by independent agency. This action, however brought about, has entirely decomposed whatever mica or hornblende the rock may have originally contained. It has also, to a great extent, decomposed the felspars and has charged the whole mass with quartz of secondary origin, which sometimes takes the form of minute stringers, but more generally spreads itself uniformly in the decomposed rock-material, and is associated with small crystals of auriferous iron pyrites and minute quantities of free gold. The same hydrothermal action which has caused the decomposition of the edge of the granitic intrusion, has evidently produced the quartz-veins found to penetrate the adjacent slaty rocks; which veins, in the neighboring "Silver Bow Basin," are found to hold gold in distinctly visible particles and small nuggets. The rock-formations met with on the part of the Alaskan coast where this mine is situated, being identical with those of the coast region of British Columbia, to the southward, it becomes important that all similar contacts of rusty or pyritous granitoid rocks with the argillites, should be examined and assayed, as it is not improbable that further deposits of the character of the Treadwell mine yet remain to be discovered there.*

* On peculiar modes of occurrence of gold referred to in the preceding pages, consult Ore Deposits, J. A. Phillips; Quart. Journ. Geol. Soc., vols. xxvii., p. 271, xxxiv, p. 4[illegible]. U. S. Geographical Survey west of the 100th meridian, vol. iii., p. 423. Trans. Am. Inst. of Mining Engineers, vol. x. pp. 340, 475, Mount Morgan Gold Fields, 1884; Mount Morgan Gold Deposits, Second Report, 1889, R. L. Jack, Queensland, Government; Mineral wealth of Queensland, 1886.

Silver.

Respecting silver-ores in the province of British Columbia, it may be stated, as the result particularly of the developments of the past two years, that these appear likely to achieve importance even before those which are distinctively auriferous. There is every reason to believe that before many years elapse the Province will take its place as one of the great silver producing regions of the world, and it is possible that silver may attain and continue to hold a greater importance than gold.

Definition of chief silver-bearing belt.

Characteristically silver-bearing ores have already been found in numerous widely scattered localities. The greater number of these, however, arrange themselves along the metalliferous belt which has already been referred to as that upon which the most important placer-deposits of gold occur. Argentiferous galenas appear to be the most abundant ores, and the knowledge of these already attained is sufficient to enable us to trace this silver-bearing belt, from point to point, from the International boundary north-westward to the 60th parallel of latitude (forming the northern boundary of the Province) and beyond it to Forty-mile Creek, where the Yukon leaves the North-west Territory to enter Alaska. The belt thus defined has the almost unexampled linear extent of about 1200 miles, and it may be said that wherever it has been explored and prospected (which has occurred generally in connexion with work on gold-placers), highly argentiferous galena ores have been found.

Discoveries in southern British Columbia.

The most considerable discoveries so far made, however, are those in the southern part of the belt, and for the most part at no great distance from the Canadian Pacific Railway. These deposits, it is fair to assume, have been brought to light on account of the accessibility of the region in which they occur; for nothing is known to show that other parts of the same belt of country, when similarly brought within reach and examined, may not prove to be at least equally rich in such ores. Even in the district in which discoveries and development are now being actively pushed at several centres, there is reason to believe that what has become known, bears but a small proportion to that which remains to be found; for by far the greater part of this rough mountainous country is still unexplored, or has been traversed only along certain routes, between which are wide, untrodden and often densely forested and rugged tracts. Thus, from every point of view, the discoveries made within a very short time in this southern portion of the metalliferous belt, must be considered as of the most encouraging character.

Modes of treating silver-ores and expense.

The principal modes of treating the various classes of silver-ores, depending on their composition, may be summarized as below :—*

Free silver, decomposed argentiferous ores or chloride minerals : Treated by free silver milling.

Silver ore, accompanied by sulphides of copper or other base metals : Low grade, fine concentration ; high grades, roasting milling.

Argentiferous copper- or lead-ores : Coarse concentration and smelting.

A large proportion of the ores found up to the present time in British Columbia, including nearly all those of the Kootanie region, belong to the last-noted class. The expense of treating such ores must vary very materially according to the cost of labour, fuel, etc., but may run from $15 to $25 a ton, and this the price of the metals in the ore must be sufficient to cover after all the cost of mining, concentration and transport to the smelter have been charged against them.

VEIN-MINING DISTRICTS (*Precious Metals*).

Classification of ore-deposits.

Under this heading, it is proposed to give a few particulars relating to the various districts which have already attracted some notice on account of the occurrence of veins containing gold and silver. Some of the deposits mentioned might with equal propriety be classed as lead-ores or copper-ores, but when these contain the precious metals in workable quantity, it becomes more convenient to include them here. As it is difficult to follow any regular geographical order, the Cariboo district, as being that in which the earliest attempts at 'quartz-mining' have been made, is placed first.

Cariboo.

History of 'quartz-mining.'

The general features of the Cariboo mining region, have already been referred to in connexion with its placer mines. Almost from the first working of the placers, the existence of numerous quartz-veins was noticed, but no particular attention was given to these till the yield of alluvial gold began to be notably diminished. It was then felt, that notwithstanding the remoteness of this district, the existence of settlement and of a considerable mining population in it, justified the attempt to develop 'quartz-mining.' This feeling brought about the premature quartz excitement of 1877 and 1878, which was based on exaggerated ideas of the richness of certain known lodes, and on erroneous views as to the facility with which gold might be extracted from the pyritous ores which these afforded. From the collapse of this

* From the Mining Journal, vol. lix., p. 278.

excitement, vein-mining received a severe check, but in spite of this discouragement, the miners of Cariboo have not relaxed their efforts toward the development of vein-mining, their attention being, as is only natural, almost entirely directed to gold-bearing quartz.

Eventual success assured.

From what is known of the district, I can entertain no doubt that it is destined to become an important vein-mining one. It has been made clear that in that part of the district in the immediate vicinity of the rich placers, there exists a great number of well-defined quartz-veins, and while such small tests as have so far been made, shew that a majority of these yield low returns in gold, some are already known to afford encouraging results, such as to warrant extensive working if the region were better provided with means of access.

Great number of veins.

The explorations of the miners have been assisted by the work (in 1885 and 1886) of Mr. Amos Bowman, of the Geological Survey. In a preliminary report already published* Mr. Bowman enumerates nearly a hundred ledges and 'quartz prospects' visited by him, adding that these do not comprise probably half the number noted or a hundredth part of the really good ledges which a prospector might find in the Cariboo country. These places are described in greater detail in his forthcoming report on the district. Notwithstanding the absence of railway communication, the prospects of the establishment of an important 'quartz-mining' industry in Cariboo were never so bright as at the present moment.

Group of promising veins.

It is, of course, impossible to mention here all the very numerous localities in which ledges have been located or noted, or even to specify those upon which more or less prospecting and exploratory work has been done. These details will find a place in Mr. Bowman's forthcoming report. It may be stated, however, that Mr. Bowman considers the following groups or series of ledges as among the more promising ones known up to the present time, and apparently worthy of special attention :—

Ledges between Island Mountain and Mosquito Creek, extending two miles. (Including "Walker," "Sadou," and "St. John's" or "Island Mountain.")

Ledges near Williams Creek, from Lowhee divide to Proserpine Mountain, extending one mile and a half. (Including "Proserpine," "Stedman," "Big Bonanza," "Enterprise," "Victoria," and "Sam Crane.")

Ledges at Burns' Mountain, Lightning Creek, entending half a mile. (Including "Perkins," "Burns' Mountain," and some of the Lightning Creek ledges.)

Ledges crossing Grouse Creek. (Including "Dufferin" and "Fountain-head.")

* Report of Minister of Mines of British Columbia, 1886.

Ledges on Snow-shoe Plateau from Break-neck divide to French Snow-shoe Creek, extending about two miles and a half. (Including "Haywood" and "Arastra".)

Ledges crossing Hixon and Cañon Creeks. (Including "Washburne," "Stewart" and "Morrison.")

Table of assays

Reference should also be made to the assays from various veins give elsewhere. (See p. 76 R.)

Transition from placer- to vein-mining.

While it is conceivable that extremely rich placer deposits, lik some of those of the Cariboo District, might be produced by the wear ing down and natural concentration of great masses of rock, throug which gold may have been very thinly scattered, or in which the gol occurs merely in small and irregular quartz stringers, there is no pro bability that such conditions are universal in the Cariboo district The very 'coarse' character of much of the placer gold and th definite localization of the richer parts of the deposits here, shew tha these must often be near their points of origin, and the problem now before the miner is that of ascertaining the sources of the gold, an discovering the rules locally applicable to the original deposits.

Points to be considered.

In connexion with this problem in Cariboo, I would invite attentio specially to the points alluded to in the general remarks on vein mining (p. 53 R) for the purpose of inducing an enlargement of th scope of the enquiry. It may also be mentioned that the very fact o the 'coarse' character of much of the Cariboo gold, goes to shew tha while gold may exist as well in paying quantities in a finely dissem inated state, much of it must evidently occur very irregularly in th productive ledges, from which it may, therefore, be necessary to obtai the average of a large quantity of rock before a conclusive test can b said to have been made. The existence of 'pay chutes' is a fac familiar to all miners, and has been found notably to characteriz gold lodes in both California and Australia. Such chutes may form but a small portion of the natural outcrop of the veins, an additiona circumstance calling for trials of lodes on a somewhat extensive scal before they can be affirmed to have been fully proved.

Relation of sulphurets to gold.

In the Californian gold belt, according to Mr. G. F. Becker, so gen eral is the association of gold with sulphurets, that where gold is no visible, miners, judge of the value of an ore by the quantity of sul phurets it contains. Mr. Becker adds:—"Quartz with plenty of sul phurets and no visible gold often occurs in large bodies, and is apt to pay better in the long run than quartz with very coarse gold, or 'specimen quartz,' as it is called by the miners."* While this rule seems to hold also to a considerable extent in Cariboo, particularly in the association of gold in veins with iron-pyrites, it would appear, so

* U. S. 10th Census, vol. xiii, p. 10.

far as experience has gone, that it is either not so constantly the case, or that the proportion of gold in the pyrites is less considerable than in the gold belt of California. This and other similar points are, however, only to be settled by exploratary work and by working tests, and as several very strong pyritous lodes are already among those best known, it will probably not be long before their character is fully ascertained.

With the object of encouraging such trials, the government of British Columbia has erected a test-mill, near Barkerville, which is at the present time nearly ready for work. There are also already in the same vicinity four small stamp-mills. Test-mill.

Kootanie.

This region includes the Selkirk and Purcell ranges and adjacent western slopes of the Rocky Mountains proper. It may be conveniently divided, for purposes of description, into West and East Kootanie, the line of separation following approximately the watershed between the two arms of the Columbia River.

Since the Selkirk Mountains have been traversed by the Canadian Pacific Railway, and have thus been rendered accessible, and a means afforded for the shipment of ores, very active prospecting has been carried on in a number of localities, and has resulted in the discovery of numerous deposits of rich ores, principally silver-bearing. This region is, at the present moment, that in which the interest of mining men is chiefly centred, and the developments so far made,—though but in their initiatory stages,—are of the most promising kind. The summer of 1889 will no doubt witness great activity in this entire region, and it is confidently expected that before the autumn the first really considerable shipments of silver-ores will have been made, and the reputation of the region as an argentiferous one well established. Though not in a position to speak from personal investigation of the localities which have quite recently sprung into notice here, I am indebted to Messrs. G. M. Sproat and A. W. Vowell, Gold Commissioners, and to Mr. G. B. Wright, for a number of particulars, upon which and on such other information as is available, the following brief notices are based :— Recent development of rich ores.

West Kootanie.—

The principal metalliferous belt which has so far attracted attention in this region, is believed to extend along the western slope of the mountains, with a width of about twenty miles and a general course slightly to the west of north, from a point six or eight miles south of the outlet of Kootanie Lake, nearly to the Big Bend of the Chief metalliferous belt.

Columbia, where the Selkirks, as a distinct range, seem to terminate somewhat abruptly. The localities on this metalliferous belt which require special notice, are, in order from south to north, *Toad Mountain Mining Camp*,* with silver and gold ores; *Hot Springs* and *Hendryx Camps*, with silver-ores and lead; *Illecillewaet*, with silver and lead ores; and the *Big Bend region*, apparently characterized principally by gold-bearing quartz.

Mining Camps.

Toad Mountain

Toad Mountain Camp.—The centre of the group of metalliferous deposits included under this name, is situated about four miles and a half south-west of the outlet of Kootanie Lake, some forty miles north of the International boundary, at an elevation of about 3900 feet above the lake, or approximately 5700 feet above sea-level. The deposits were discovered in the autumn of 1886. They occur principally in a belt of calcareous rock (called by the miners a lime-shale), which is said to be bounded on both sides by granite. This belt has a width of a little less than a mile, and has already been imperfectly prospected for a length of five or six miles. The course of the metalliferous belt is nearly east-and-west, running along the northern slope of the high, southern mountain-wall of the valley of the Kootanie River. The silver-bearing lodes are, however, not strictly limited to the above described belt, but have been found also in various places several miles removed from it. The claims registered in and near the Toad Mountain Camp numbered on the first of August last 228. The deepest shaft at that time did not exceed seventy-five feet, and most of the shafts or tunnels were much less than this in depth or length. The most prominent claims at the present time appear to be those in the Hall Brothers group, the "Silver King," "Kootanie Bonanza" and "American Flag." The first-named is that upon which the largest amount of work has been done. The outcrop of the vein here showed an apparent width of about twenty feet, but is reduced to a width of from six inches to four feet, at the depth to which it is now opened. There are no well-defined walls, the ore being apparently incorporated closely with the country-rock. The ore is said to consist of copper-stained iron-ore, peacock copper, copper-pyrites and tetrahedrite, with streaks of what the miners term 'brittle silver,' and is often very rich. Assays of choice specimens are said frequently to run from 100 to 1700 ounces of silver to the ton. I have seen the returns of a trial shipment of twenty-two tons of ore, sent for treatment to Montana, which yielded $6463, chiefly in silver. The ore was hand-picked, but not otherwise concentrated. It was divided into two lots, which assayed respectively:—

Silver ores.

"Silver King."

Trial shipments made.

* The expression "mining camp" is here used in its western sense, as a convenient and generally recognized term for a mining district of limited area, more or less definitely separated from others

	I.	II.
Silver	297·70 oz.	285 oz.
Gold	$2·16	$1·44
Copper	28·9 %.	27·2 %.

Other small shipments have since been made of similarly rich ore, but no systematic plan has yet been adopted for working the mine on a large scale.

Other claims shew a greater amount of galena, which is apparently present in the "Silver King" ore in very small quantity only. The "Dandy Mine" and the "Tough-nut Mine" are mentioned as shewing veins from four feet to ten feet wide, the ore from the latter being stated to assay about $100 to the ton in silver. About sixty claims in all have been partially prospected or opened up to a limited extent, most of these being within an area about three miles in length. Character of ores and veins.

West of the silver-bearing veins, and upon Cottonwood Creek, near the Kootanie River, claims have been located which show rich free-milling gold-ores. These have lately been bonded for $40,000, which amount is believed to be covered by the ore in sight, while another gold-bearing deposit has been purchased, the intention in both cases being to put in stamping machinery in the spring. Gold ores.

Most of the claims in this camp appear to be held by the discoverers at very high prices, which circumstance has up to the present time somewhat tended to prevent its rapid development.

Hot Springs Camp.—The Hot Springs Camp is situated on the west side of Kootanie Lake, about thirty-five miles from the last. It may be said to embrace an area of about five miles by three, lying between Coffee and Woodberry creeks. The country-rock is described as being a mica-schist, with associated magnesian limestone, and it is said that some of the veins can be traced without apparent break or interruption for distances of one or two miles, with widths varying from two to eight feet. The argentiferous galena appears to be somewhat irregularly distributed in these veins, with a thickness varying from a few inches to three feet. Near the lake the ores are stated to assay from twenty to forty ounces of silver to the ton, but at a greater distance and elevation, the ores appear to be more decomposed, assuming a rusty appearance, and being known to the miners as 'carbonate ores.' The ores of this class are generally found to be richer in silver. About sixty claims have been partially developed in this camp. During the past season a considerable amount of capital has been invested here and good prospects have sold well. The highest price so far paid for a claim is $20,000, on a bond, a few days only after its discovery. Other claims and interests in claims have changed hands at prices ranging from $5000 to $1500. A considerable quantity of ore Hot Springs Camp. Argentiferous galena.

is now being brought down to the edge of the lake in small lots for shipment.

Quantity and quality of the ore.

In a letter received from a gentleman well able to judge of the facts, it is said that in quantity the ore of the Hot Springs Camp will equal the Cœur d'Alaine mines, while in quality the ores are much better, some of them carrying three or four times the amount of silver to the ton. According to the same authority, it is stated that it appears that there are several distinct veins running northerly and southerly for a distance of about five miles, all shewing a continuous body of fair grade ore, say thirty ounces to one hundred ounces of silver, and sixty per cent. or more of lead, and that for each hundred feet in vertical depth the various veins already discovered will eventually turn out 500,000 tons of shipping ore in the aggregate.

Various claims.

Of the numerous claims taken up in this camp, some of those which have attracted most attention, and for which notes are available, are enumerated below. As before explained, while unable to speak from personal knowledge of the accuracy of the statements made, I have every reason to believe that they are in the main correct:—

"Little Donald Mine."—Situated 1250 feet above the lake. Vein, eight feet wide, shows two feet and a-half of galena, which assays 60 to 130 ounces of silver to the ton, and 60 per cent. of lead. "Krao Mine."—Galena obtained here said to run over 100 ounces of silver to the ton, and a few tons of rich 'carbonate' ore yielded 280 ounces to the ton at Butte City. "Sunshine Mine."—Apparently a strong vein, six feet wide, but little developed. Runs N. 60° W., cutting across the others. Assays said to average sixty ounces silver to the ton. "Gallagher."—Situated higher up the mountain than those above-mentioned. Ore largely the so-called carbonate ore, *i.e.*, galena, etc. decomposed by sub-aerial agencies, soft and easily worked. Assays said to run from 60 to 190 ounces silver to the ton. Contains about 10 per cent. of lead, with a large quantity of iron oxide. "No. 1 Mine."—On a line with the last. Ore of the same character. Assays from 60 to 500 ounces of silver to the ton.

Hendryx Camp.

Hendryx Camp.—Situated on the east side of Kootanie Lake, opposite Hot Springs Camp, the lake being here about a mile and a-half wide. The galena ores of this place are said to have been discovered by the botanist Douglas in 1825, and have frequently been referred to, but have only of late come into prominence, though locations have been taken up and successively abandoned several times. The ore is understood to be of comparatively low grade, but to occur in great mass and to be of easy access, being situated close to the shore of the lake. The "Blue Bell Mine" is owned by the New Haven Mining & Smelting Co., which has already spent $100,000 in preliminary work. The galena

Character of its ore.

here occurs in a series of parallel veins, separated by bands of limestone, and associated with oxidized vein-matter. The vein is reported traceable on the outcrop for over 400 feet, and has been cut across at some depth by a tunnel 195 feet long, and shows in one place an unbroken body of galena ore 86 feet in width. The galena is said to assay from 15 to 40 ounces of silver to the ton. Several hundred tons have been shipped and several thousand are plainly in sight. The "Kootanie Chief" and "Comfort" mines, in the same vicinity, are owned by the Ainsworth Syndicate. Little development has yet been made on either of these, but their appearance is reported to be equally favourable with the last.

Great size of veins.

In addition to the above recognized 'camps,' it may be stated that in this region numerous isolated 'prospects' of silver-bearing galena have been found in the same general district. One of these is situated about eight miles west of the Columbia River, near the Boundary; and another to the east of the Columbia, on the summit of the divide between Slocan Lake and Kootanie Lake. 'Prospectors' report a very large surface showing of galena at this place. Following the Lardo River, which enters the north end of Kootanie Lake from the north-westward, nearly on the line of the main metalliferous belt referred to on a former page, we find several lodes of silver-bearing ores reported, but respecting the extent or richness of these nothing absolutely certain is known. On the north-eastern arm of the Upper Arrow Lake, known as Galena Bay, locations have been recorded on a vein which is said to assay 50 ounces in silver to the ton, and on the head waters of Fish River, running into this bay, another vein is reported, yielding about 100 ounces in silver to the ton. Continuing a short distance still further northward, we reach the Illecillewaet River and line of the Canadian Pacific Railway.

Continuation northward of metalliferous belt.

Illecillewaet Mines.—This group of mines is chiefly contained in the angle between the north and south branches of the Illecillewaet River, in a very mountainous country. Over 200 claims have been located here, and on sixty or seventy of these the work necessary to hold them under the provincial mining law, has been done. Some of the claims are not far above the valley, but many are high up in the dividing ridge between the two rivers, and the ore so far brought down from there has been carried on mule-back.

Illecillewaet

Dr. Selwyn describes the mode of occurrence of the ores here as follows.*—

Mode of occurrence of ores.

"The argentiferous galena of Illecillewaet occurs chiefly in quartz-veins, cutting a series of black carbonaceous or graphitic slaty shales,

* Summary Report Geol. Surv. Can., 1887, p. 4.

and thin bedded limestones, often much folded, but shewing an average dip of from 35° to 40° to E.N.E., and apparently flattening towards the summits of the mountains. Most of the veins are parallel with the stratification, though not unfrequently passing from one bed plane to that of another. No fossils have yet been found in these slates, but they closely resemble the black graptolitic shales, described by Mr. McConnell, p. 22 D, Annual Report Geological Survey, 1886, and may be of Cambro-Silurian (Ordovician) age."

Work done on claims.

This group of mines has been, on the whole, more fully developed than any in the Kootanie region. During the past two years, galena and 'carbonate' ores have been shipped in larger or smaller quantities to Omaha or San Francisco, for smelting purposes. Work has been steadily carried on by several companies with a view to development. A two-thirds interest in one claim has been sold as a 'prospect' for $16,000, and many 'prospects' have changed hands at $3000 down to small or nominal sums. The Selkirk Mining & Smelting Company has sent out about 500 tons of ore, derived principally from the "Lanark Mine," which is situated in sight of the railway, but at an elevation of about 3000 feet above it. This ore is stated to have produced about 100 ounces of silver to the ton. The erection of an aerial wire tramway is contemplated. About 500 feet of tunnels have been driven to intersect the lode, the lowest being at 400 feet below the level of the out-crops, and about 300 feet of drifting in the lode has been done. The same company holds the "Sutton," "Sprague," "Whale" and "Shark" claims to the north-west, and the "Isabella" and other claims in a south-easterly direction from the "Lanark." The Corbin & Kennedy Company also own several claims, of which their "No. 2" is stated at the present time to be the most promising. This vein is said to be from four to eight feet in width, and has been penetrated by tunnels for a hundred feet. It is a concentrating ore, and can be reduced to one-tenth by ordinary methods of concentration, the concentrates being reported to run from 300 to 400 ounces of silver to the ton. Promising veins of galena and grey copper ore are covered by other claims, from which assays running from 100 to 2800 ounces (in one instance) have been obtained, but no systematic work has yet been performed on any of the properties, with the exception of those above mentioned. Gold occurs only in traces in these ores. There is a crushing and sampling mill, capable of treating one hundred tons of ore a day, at Illecillewaet Station, on the railway, and a small village has sprung up there. This 'camp' seems to show every appearance of becoming a permanent ore-producing one of considerable importance.

Various claims.

Gold only in traces.

Big Bend.—Very little is yet known respecting the prospects of vein-mining in this part of the Kootanie region, but what information has been obtained is of a favourable character. There appear to be indications that the argentiferous belt runs northward from Illecillewaet through it. The placer-gold mines of the district have been referred to on a former page (p. 39 R), and a number of quartz-veins are reported, from which some exceedingly rich specimens of gold have been brought. Prospecting has, however, so far, chiefly been turned toward placer mines, of which Gold Creek and its tributaries are the most noted localities. These are reached by river, or by trail of about sixty miles in length from Revelstoke. It is probable that prospecting for veins will be actively carried on here in the near future. On Carnes and McCulloch creeks veins of argentiferous galena are reported. Big Bend.

In his official report for 1888, Mr. Sproat writes, of the West Kootanie District,—"We already, when nothing beyond 'prospecting' work on mineral claims has been undertaken, have marketed about 600 tons of silver-ore—most of it in galenite, of which total about 60 tons have returned over 300 ounces; 100 tons, 110 to 150 ounces; and 440 tons, 60 to 70 ounces, silver, per ton. The close of the season, and want of means of transport, alone prevented more of the higher grades from being marketed. The time is not far distant when I shall have to report to you a product of 500 tons a day of silver ores from this district, with a fair proportion of ores of high grade."* Future of the mines.

East Kootanie.—

What may be described as the East Kootanie division, includes the eastern slopes of the Selkirk and Purcell Mountains, the upper parts of the Columbia and Kootanie valley, (separating those ranges from the Rocky Mountains) and the western slope of the Rocky Mountain Range. The discoveries so far made of deposits of the precious metals in this district, other than placer-mines, appear to be confined to that portion of it to the south of the railway. Here, during the year 1888, according to Mr. A. W. Vowell, the Gold Commissioner, 102 claims have been taken up, upon twenty-three of which assessment work has been performed; but with the exception of certain claims at Mount Stephen, no mining work of importance has yet been undertaken. The prospects of the district as a whole are, however, at the present moment extremely encouraging, and there is every reason to believe that mining will here before long be prosecuted with vigour. Claims taken up.

The localities which have up to the present time attracted most attention, and round which most of the claims are gathered, are as follows:—Mount Stephen, near Field Station, Canadian Pacific Rail- Principal localities.

* Report of Minister of Mines of British Columbia, 1888, p. 302.

way; Otter-tail, near the station of the same name; Spilimichene and Jubilee Mountain, Columbia River; Spilimichene River, Second Fork; McMurdo district, near head of the Spilimichine River.

Mount Stephen

At Mount Stephen (Tunnel Mountain) the four original claims, known as the "Monarch," "Cornucopia," "Alpha" and "Mogul," are stated to have been sold for $25,000 to the British Columbia Smelting Company, which company has expended a large sum in opening up the deposits, and has already, to the end of 1888, shipped about 600 tons, chiefly from the "Monarch," to their works at Vancouver. The geological formation of this locality is fully described by Mr. R. G. McConnell in a late report of the Geological Survey,* where some account of the mineral deposits is also given. The ore is galena, which frequently appears in considerable mass, nearly pure. It seems to impregnate a zone of interbedded calcareous rocks, and had been traced for a considerable distance even before the work previously spoken of had been carried out. It is most favorably situated for shipment, but carries a very moderate amount only of silver, which, according to assays made in the laboratory of the Survey, varies from four to eleven ounces to the ton.

Otter-tail.

At Otter-tail, one of the claims is situated directly under the railway-track, and several others at no great distance from it. In the report last referred to, the ore is described as an argentiferous galena, associated with some copper and zinc, and holding traces of gold. It occurs in quartz and calcite veins, which run parallel or nearly so to the strata of the calcareous schists and limestones of the district. The veins seldom exceed eighteen inches in thickness, but the ore is reported in some instances to contain a high percentage of silver. Several assays made in the laboratory of the Survey run from 5·8 to 113·7 ounces o[f] silver to the ton.

Cinnabar.

Further down the Wapta (Kicking Horse) River, not far fro[m] Golden, and also in the immediate vicinity of the railway, a vein o[f] white calcite holding flecks of bright red cinnabar, has been 'prospected' to some extent.

Copper ores.

The deposits of copper-ore met with in Copper and Castle mountain[s] and in their vicinity, may also be alluded to here, though, as they occu[r] to the west of the water-shed, they lie beyond the eastern boundary o[f] British Columbia. Massive specimens of purple ore have been obtaine[d] at the first-mentioned locality, and some work has been attempted i[n] connexion with the deposits, though so far without important result[s]. The precious metals are found in these ores in very small quantity, an[d] generally speaking, the result of numerous assays made up to the pr[e]sent time, is to shew that neither the lead- nor copper-ores of the Rock[y]

* Annual Report Geol. Surv. Can., 1886, Part D.

Mountains proper in this region, compare favourably in this respect with those of the Selkirk and Purcell mountains.

Jubilee Mountain, situated on the west side of the Upper Columbia River, about thirty miles south of Golden Station, and in easy communication with that place by the river, has been the scene of considerable 'prospecting' operations during the past two years. The ore-deposits here are said to occur in a limestone formation and to be very massive, though of somewhat low grade in silver and containing scarcely any gold. The specimens received, show much copper in the form of copper-glance and other sulphurets and some galena. They are generally much decomposed, and present a rusty or greenish appearance. Assays of the richer specimens made in the laboratory of the Survey run from 5·1 to 39·37 ounces of silver. Thirty-five claims were recorded here or in this vicinity in 1888. Jubilee Mountain.

In the vicinity of the Spilimichene River, which flows into the Columbia thirty-seven miles south of Golden Station, active 'prospecting' has been in progress, the discoveries being in three groups, known as Spilimichine Mountain, Second Fork of Spilimichine River and McMurdo District, including the Middle Fork of the river. Not having had an opportunity of visiting these places, I am not in a position to give details relating to them. In 1888 nine claims were taken up in the first, nine in the second, and twenty-one in the third. The "Spilimichine" and "Rothschild" claims, taken up in 1884, are said to be upon a ledge of great size, containing galena and reported to average $12 to the ton in silver, without concentration. Four claims, known as the "Southern Cross," "Monitor," "Great Republic" and "Old Dominion," in the McMurdo district, are stated to have been bonded for $36,000, and others have been sold. Assays are said to run from $15 to $200, almost entirely in silver. Specimens of ores received consist of quartz, holding galena, with some tetrahedrite, copper-pyrites, etc. Two assays made in the laboratory of the Survey shew 13·88 and 37·53 ounces, respectively, in silver, but it is doubtful whether these fairly represent the general character of the ores. Vicinity of Spilimichene River. Various claims.

Five claims have been recorded lately on Wild Horse Creek and a like number on Toby Creek, covering deposits of argentiferous galena. Ore from the first-mentioned place is reported to contain $20 to $80 in silver, from the second 65 ounces of silver to the ton. The lode on Toby Creek is said to be very large and well-defined, and has been partly opened up on the "Jumbo claim." Wild Horse and Toby Creeks.

Interior Plateau Region.

Principal localities.

In a number of places in the southern part of the Province, included between the Gold and Coast ranges, or on the western and eastern flanks respectively of these mountain systems, discoveries of ores holding silver and gold have been made. Of these the following require special mention as being those in which groups of claims have been located and some 'prospecting' and exploratory work undertaken. Of these Stump Lake and Rock Creek are, however, the only ones which, as yet, are entitled to be called 'mining camps':—Cherry Creek, Rock Creek, Stump Lake, Jamieson Creek, Upper Tulameen, Cayoosh Creek, and Big Slide.

Cherry Creek.

The occurrence of exceptionally rich silver-ore at Cherry Creek, thirty-three miles east of the head of Okanagan Lake, has been known for a number of years, and several attempts have been made toward the development of the deposit, but difficulty has been experienced in following the vein. The "Hidden Treasure Mining Company" are at present engaged in prosecuting exploratory work on a scale more extensive than previously attempted, and apparently with fair prospects of success. The ore consists of argentiferous tetrahedrite or freibergite, with galena and blende, the gangue being quartz, and the country-rock blackish shales or slates. Average specimens broken from a large mass of the richer ore, yielded on assay 658·43 ounces of silver to the ton. In addition to the vein here particularly referred to, several other silver-bearing veins have been found in the same neighbourhood, and pellets of galena found in the sluice-boxes on the creek above the out-crop of the principal vein, yielded at the rate of 220·93 ounces of silver to the ton. These doubtless indicate additional silver-bearing deposits which have not yet been discovered.

"Monashee ledge."

Eight miles south-eastward from the placer-mines on Cherry Creek, on the south slope of the mountains between Cherry Creek and Kettle River, is the so called McIntyre or "Monashee" ledge. This is said to contain free gold. Some 'prospecting' has been done upon it and a trail has been cut out from Cherry Creek to the ledge.

Rock Creek and vicinity.

The general character of Rock Creek, situated a short distance north of the International boundary, and east of Osoyoos Lake, is elsewhere noted in connexion with its placer gold-deposits (p. 38 R). This locality has been visited by Mr. Bowman of the Geological Survey, but at that time little had been done in the matter of quartz discovery. During the past two years, however, general attention has here been turned in this direction, and very promising discoveries are reported, including both free-milling gold-ores (yielding some very rich specimens) and argentiferous galena-ores. On a claim known as the "Cariboo,"

a tunnel 200 feet in length is reported to have been driven, as well as a couple of shafts of fifty feet in depth. On the "Argen" claim, a prospecting shaft forty-two feet deep has been sunk, and the "Vancouver" has been opened to a depth of fifteen feet. On the "Eureka" is a shaft of about one hundred feet. A little mining town has already sprung up here.

At a place about twenty-five miles west of Rock Creek and twelve miles north of the Boundary-line, discoveries reported to be important have been made within the past few months. The ore is described as containing galena and free-milling gold. Twenty-eight locations have so far been recorded here.

Nicola or Stump Lake mines.

In the year 1887, 200 claims were recorded in the vicinity of Stump Lake, and during the summer of 1888, I had the opportunity of examining a number of these, comprising all those upon which any considerable amount of work has yet been done. Some locations were originally taken up in this neighbourhood about six years ago, but 'prospecting' work appears first to have been undertaken in 1885. The principal developments are comprised within an area of about five miles in length, with a variable breadth, lying nearly north-and-south on the east side of the lake. The claims included in the property of the "Nicola Mining Company" and in the adjoining property of the "Star Mining Company," are those upon which the most extensive operations have been undertaken, confined, in the case of the first-named property, to development by means of several shafts and 'prospecting' on the surface. In the case of the second, a small crushing and concentrating plant has also been established. Development and 'prospecting' has also occurred to a considerable extent by the "Mary Reynolds Company" on the "Hepburn" group of claims, on the opposite side of the valley and further south than those above mentioned, and from these, some of the richest ore, of which very satisfactory trial shipments have been made, has been obtained.

Developments made.

Mr. W. J. Sutton reports that up to the end of the year 1888, about 2000 feet in all of good working shafts and tunnels have been run in the course of development of these Stump Lake or "Nicola" mines.

Character of the viens.

The metalliferous veins which have been found within the limited district above defined, are very numerous. They vary from about ten inches to five or six feet in width, and some of them have been traced for a length of several hundred feet. Though it is probable, from the great number of veins which exist, that no single one will be found to be continuous for a very great distance, a large supply of ore is already assured. Most of the veins run with very considerable uniformity in bearings a few degrees west of true north, or from N. 10° W. to N. 30° W. magnetic. There are, however, a few which diverge widely from

this direction, and two or three which run nearly at right angles to it. The gangue is generally white quartz, and the principal metalliferou minerals present include iron- and copper-pyrites, galena, blende and tetrahedrite. Assays made in the laboratory of the Survey, ru from 15 to 406·5 ounces of silver, with 0 to 6 ounces of gold per to of 2000 lbs., according to the relative amounts of the various minera constituents. The country-rock consists of altered volcanic material of Palæozoic or Triassic age and may be generally characterized a a diabase-porphyrite, the most characteristic material in this plac being a rock of green and green-grey colour with coarse porphyriti crystals of plagioclase and pyroxene.

Encouraging prospects.

On the whole, the prospects for the immediate development of a important mining district are here most encouraging. The occurrenc of these ores in the green, altered, volcanic rocks, which under slightl varying forms occupy so large an area of the southern interior o British Columbia, is a feature of peculiar interest, inasmuch as it lead to the belief that these wide-spread rocks become a metalliferous serie where the other conditions are favourable.*

Jamieson Creek

In the vicinity of Jamieson Creek, which flows into the Nort Thompson from the west, fifteen miles from Kamloops, a number o claims have been recorded within the past two years, though very littl work has yet been done on them. The veins occur in a mass of grey ish granite, which breaks through certain black micaceous schists o argillites which form an important intercalation in the Palæozoi rocks, generally of volcanic origin, of this part of the Province The granite is highly silicious in the vicinity of the veins, and thes appear to have been produced contemporaneously with the intrusion o the granite. The gangue is quartz and contains pyrites, with a littl galena, blende and tetrahedrite. Assays made in the laboratory o the Survey shew from seven-tenths to one ounce of gold and tw and a-half to thirty-four ounces of silver to the ton. Little can as y be proved respecting the continuity of the veins in this district, an the area within which claims have been recorded is comparativel small. The surface display of quartz is, however, considerable, an this, with the rich character of the ores, would appear to warrant som expenditure of a tentative character. The thickest vein seen is fro five to six feet in width. It may further be mentioned in this conne ion that similar veins were seen by us near the the head-waters o Jamieson Creek.†

* See Summary Report Geol. Surv. Can., 1888, p. 6. Report of Minister of Mines of B.C. 1887, p. 275.

† See Summary Report Geol. Surv. Can., 1888, p. 7.

On the Upper Tulameen, above Granite Creek, several quartz-veins have lately been discovered, but nothing except a limited amount of preparatory work has yet been done toward their development. I may state, however, that the district appears to be worthy of attention by the 'prospector,' as it presents very favorable indications, and the rocks often show evidence of solfataric action, being highly silicified and holding much pyrites in certain belts. A specimen of ore collected by myself at the "Bonanza Queen" location, has since been ascertained on assay to contain 1·3 ounces of gold, and 5·1 ounces of silver, to the ton of 2000 pounds. A remarkable indication of the existence somewhere in the Tulameen basin of extremely rich ores, is found in the discovery in sluice-boxes on the river, about thirteen miles above Granite Creek, of small rolled pellets of pure silver-glance strung through with filamentous gold. Tulameen region.

On Mad River, a tributary of the North Thompson above the Clearwater, a vein has been discovered and prospected, a specimen from which yielded on assay in the laboratory of the Survey gold 4·37 ounces silver 21·35 ounces to the ton. Locations have also been made on the Clearwater, Deception Creek and Mahood Lake, but their character has not been proved. North Thompson.

The quartz-veins recently found on Cayoosh Creek, near Lillooet, about twelve miles up the creek, are the sources from which the gold of the rich placer-deposits which have been worked there during the past few years, has been derived. Assays of quartz from these veins made in the laboratory of the Survey, give a remarkably favourable showing, the gold being free and minutely and uniformly distributed through the rock. These assays run from 0·722 to 0·992 ounces in gold to the ton. The country-rock is a dark, slightly micaceous slate or schist. This is much broken up and disturbed, and the veins are very numerous, but small and apparently irregular. It would appear to be worth ascertaining, at this place, whether some portions of the rock with its included veins would not pay for extraction and crushing as a whole. The work yet done here is merely 'prospecting.' A discovery is reported to have been made in 1888, in this vicinity, between the head of Anderson Lake and McGillivery Creek, of a strong lode of quartz containing galena, and assaying to the value of $46 in silver with $14 in gold to the ton. Cayoosh Creek.

On the "Big Slide Mine," the property of the Foster Mining and Milling Co., a considerable amount of work has been done and expenditure incurred in bringing in and erecting crushing and chlorinating machinery, etc. The deposit, which was discovered in 1872, is situated on the bank of the Fraser River near the mouth of the Kelly Lake Creek. The vein is reported to be from fifteen inches to five feet in "Big Slide mine."

width and traceable for a long distance. The average value of the ore is reported as $22·50 to the ton, of which $20 is gold. The highest assay reported is one of $118. Operations are at present suspended, owing to difficulties met with in saving the gold.*

Coast Ranges.

Silver mines near Hope.

The most important discovery of silver-ore yet made in the Coast Mountain belt is that near Hope, on the Fraser. The veins here run through a mass of conglomerate which caps a mountain known as Silver Peak, of which the lower part is composed of granitoid rocks. The conglomerate is believed to be of Cretaceous age. Difficulties which have occurred in connexion with ownership, have unfortunately so far prevented the working of this very promising deposit. The fol-lowing notes concerning it are chiefly derived from the Report of the Minister of Mines of British Columbia for 1874, p. 16.

"Eureka" and "Van Bremer"

About 1871, veins of silver-ore were discovered in the Coast Moun-tain Range at Fort Hope about six miles south of the town. The first vei discovered, named the "Eureka," crops out about 5000 feet above th river-level, is well defined, and from four to seven feet thick, and ha been traced 3000 feet. A tunnel 210 feet long has been driven int this vein. For milling purposes, the ores would have to be lowere about 3000 feet to Silver Creek, distant about 6000 feet. The ore i described as argentiferous grey copper, and contains from $20 t $1050 of silver to the ton. While this vein was being opened, an other, about 300 feet distant, was discovered. This is much riche and is called the "Van Bremer." The ore is described as chloride o silver, and the vein contains from $25 to $2403 of silver to the ton. quantity taken from the out-crop sold at San Francisco for $420 a to This vein can be traced for half a mile.

A specimen of the Hope silver-ore—"a yellowish decomposed vei stone"—assayed by Dr. Harrington gave 271·48 ounces of silver the ton of 2000 lbs. It also contained lead, copper, antimony, iro arsenic and sulphur.

A specimen from the "Eureka" mine—"a vein-stone of spathic ir with some quartz"—assayed by Dr. Hunt, gave 347·08 ounces of silv to the ton of 2000 lbs., and contained also copper, antimony and s phur.

"Murphy's Mine."

About two miles above Hope, on the opposite side of the Fraser, vein occurs which is reported to hold silver to the value of $15 to to the ton. Some work has been done here in former years, and tunnel 540 feet long driven for the purpose of intersecting the vein.

* See Reports of Minister of Mines of B.C., 1886, pp. 211, 216, 1887, p. 273.

Yale. Some work has also been carried on from time to time, but so far without leading to any considerable developments, on veins situated on Yale Creek, near the town of Yale. Ore from the "Queen Mining Company's" claim is reported to contain galena, blende, iron- and copper-pyrites and to have afforded assays as high as $38 to the ton, in silver.*

Omenica.

Arquerite. The situation and character of the Omenica country has already been noticed in connexion with its gold-placers (p. 41 R). In association with the gold in some of the creeks, arquerite, a species of silver amalgam presenting the outward appearance of native silver, is found in grains and nuggets (p 145 R). This mineral consists of silver combined with mercury.† It has not yet been found in place either here or elsewhere in the Province, but it is worth noting that it constitutes the principal ore in the mines of Arqueros, Coquimbo, Chili. Also, however, in the immediate neighbourhood of the gold-deposits is a number of large veins carrying highly argentiferous galena, which, from the accounts received of them, appear to require only improved means of communication to ensure their profitable working. A number of claims were at one time taken up upon these, but they have probably since been abandoned. The "Arctic Circle" and "Black Warrior" are adjoining claims on Boulder Creek. The former is said to shew a vein twenty feet wide with about four feet of highly metalliferous ore. The latter is described as a vein eight feet wide of nearly pure galena. Other specimens of similar ores have been obtained from several places within a radius of eight miles of these. The "Champion ledge" is situated near Lost Creek and is similar in character, but particulars concerning it are wanting. Another vein on this creek is reported to be twenty feet wide. Assays run from 29·8 ounces to 128 ounces in silver to the ton, the last mentioned representing a galena free from gangue. Some specimens also carry an appreciable quantity of gold.‡

Argentiferous galena ores.

Other Localities.

Discoveries in Cassiar. Still further north-westward, in the same general line, is the Cassiar District (p 43 R), in which practically nothing has yet been done toward the discovery or development of any but placer-mines. Large

* See Reports of the Minister of Mines of British Columbia, particularly report for 1879, 245.

† The mineral when pure consists of silver 86·5 per cent. Mercury 13·5 per cent. A nugget from this district, analysed by Messrs. Riotte and Leckhardt, of San Francisco, contained silver 85·80 per cent, mercury 11·00, lead 0·40, copper 0·20, as well as traces of gold, platinum, and iron

‡ Report of Progress, Geol. Surv. Can., 1879-80, p. 110 B.

veins of quartz are reported to occur in the vicinity of some of the auriferous streams, and an attempt was at one time made to work some of these on a small scale by means of an arastra. Argentiferous galena ores also occur here, a specimen of one of which, from the South Fork of McDame Creek, on assay in the laboratory of the Survey proved to contain 75 ounces of silver to the ton, while still higher assays have been reported.

Silver-ores in Yukon district.

Far beyond the northern boundary of the province of British Columbia, and still following the same belt of country, upon Forty-mile Creek, near the point at which the Yukon crosses the 141st degree of longitude (p. 44 R), argentiferous galenas are again found, one of which collected by Mr. W. Ogilvie and lately examined, contains over 3[illegible] ounces of silver to the ton.

Queen Charlotte Islands.

It is not possible here to include mention of the numerous isolated localities in which discoveries of ores of unproved value have been made or in which they have been reported. A number of these appear in the list of localities and in the table of assays on later pages. Allusion is elsewhere made to the exceptionally rich, though apparently quite limited gold vein of Mitchell Harbour, in the Queen Charlotte Islands (pp. 17 R, 143 R). This occurrence seems, at least to hold out encouragement for further search in the rocks of the same character as these inwhich it is, and which are very largely developed upon the coast of the Province.

Texada.

During the last few months attention has been drawn to the existence of gold-bearing veins on Texada and a considerable amount of 'prospecting' has been carried out on the island and a large number of claims have been recorded. The ores are said to be pyritous and favourable assays are reported, but I am unable to give any definite particulars respecting them. Their character will doubtless be fully proved during the coming summer.

"Stirling Mine."

Reference may also be made here to the "Stirling Mine," Kokesil[ah] River, about twelve miles from tide-water, Cowichan District, Vancouver Island. Some 'prospecting' work has been done here. The ore is an argentiferous galena with some gold, and assays are quoted showing from $10 to $75 in silver to the ton.*

* Report of Minister of Mines of British Columbia, 1889, p. 431.

TABLE OF SELECTED ASSAYS OF ORES FROM BRITISH COLUMBIA, CONTAINING GOLD AND SILVER.

NOTE. *Most of the assays quoted here in summary form, have been made in the Laboratory of the Geological Survey. The various reports in which there are given at length, are denoted simply by the date and page, in the last column. Those to be included in the report for 1888, have not yet been published. A few additional authentic assays from other sources, are also quoted. (Names of minerals specially prominent in any ore are printed in italics.)*

Cariboo District.

No.	LOCALITY.	ASSOCIATED MINERALS.	GOLD. Ounces.	SILVER. Ounces.	Reference.
1	"Big Bonanza," between Williams and Lightning Creeks, Cariboo. (Highest assay of specimens received)	Quartz with some pyrites	0·554	....	76-77, p. 478
2	Cariboo, average of 9 samples (separate localities not stated.)	....	1·424	0·766	77-78 p. 49 G.
3	"Discovery claim," Little Snow-shoe Ck., Cariboo	Rusty quartz with limonite and iron-pyrites	0·408	0·058	87, p. 40 R.
4	"Flynn's diggings," Mosquito Ck., Cariboo	Galena and iron-pyrites	0·182	26·459	87, p. 44 R.
5	"Dufferin ledge," Grouse Ck., Cariboo	Quartz with *pyrites*	2·042	0·292	87, p. 45 R.
6	"Proserpine ledge," Barkerville, Cariboo	Quartz, chlorite, iron-pyrites, galena	0·787	20·138	87, p. 45 R.
7	"Home Rule ledge," Barkerville, Cariboo	....	traces	25·521	87, p. 45 R.
8	"Perkins ledge," Burns Mt., Cariboo	Rusty Quartz with galena	2·625	8·033	87, p. 46 R.
9	" " "	*Galena*, quartz, iron-pyrites	0·365	29·896	87, p. 46 R.
10	Hixon Creek Mine Cariboo	....	0·404	1·225	87, p. 47 R.
11	" " "	Quartz with copper-glance, copper-pyrites, galena, etc.	0·583	29·983	86, p. 37 R.
12	" " "	(Concentrates)	8·021	18·229	86, p. 37 R.

West Kootanie.

No.	LOCALITY.	ASSOCIATED MINERALS.	GOLD. Ounces.	SILVER. Ounces.	Reference.
13	Toad Mountain	Association of Limonite, calcite and quartz, with copper pyrites, tetrahedrite and iron-pyrites	....	59·687	1888.
14	Toad Mountain (vicinity of)	Bornite and quartz	....	119·216	87, p. 50 R.
15	"Silver King Claim," Toad Mt., (assay by Johnson & Matthey)	(Specimens collected by Mr. R. D. Atkins)	trace.	771·000	
16	"Silver King Claim," Toad Mt., (assay by Johnson & Matthey)		trace.	422·000	
17	"Silver King Claim," Toad Mt., (assay by Johnson & Matthey)		trace.	75·800	
18	"Silver King Claim," Toad Mt., average assays of trial shipment, in two lots	Contained copper 28·9 p. c.	0·108	297·70	
19		" " 27·2 p. c.	0·072	285·95	
20	"No. 1 Claim," Hot Springs Camp, Kootanie Lake	Decomposed vein-stuff with galena "carbonate ore"	trace.	214·457	1888.

21	"Lu-lu Claim," west side Kootanie Lake	Galena	traces.	15 454	85, p. 26 B.
22	"International Claim," west side Kootanie Lake?	*Galena*, tetrahedrite, etc	2 787	60 871	1888
23	"International Claim," west side Kootanie Lake	Chiefly galena	traces.	10 719	85, p. 26 B.
24	Fifteen miles up Fish River, Upper Arrow Lake	*Galena*, iron-pyrites and quartz	..	158 646	1888.
25	Illecillewaet River	Galena, blende, iron-pyrites, quartz	trace.	45 2 8	87, p. 52 T.
26	" " north side	Quartz, iron-pyrites, galena		247 357	87, p. 53 T.
27	" " south side	Galena, tetrahedrite, iron-pyrites, quartz	..	484 167	87, p. 53 T.
28	Three miles up N. Fork Illecillewaet, east side	*Galena* with a little quartz and calcite	....	80 937	1888.
29	"Minnie F. Claim," six miles up N. Fork, Illecillewaet, east side	Quartz, *galena*, tetrahedrite, iron and copper-pyrites		139 427	1888.
30	Six miles up N. Fork Illecillewaet, west side	Quartz, *galena* copper-pyrites	trace.	30 968	1888.
31	"Edmond's Claim," two miles from Illecillewaet station, N. of C. P. Ry	Quartz, *galena*, iron-pyrites, etc		1,6 302	1888.
32	"Maple-Leaf Claim," Illecillewaet River	*Galena* with calcite, etc	..	65 635	86, p. 40 T.
33	"Shamrock Claim," Illecillewaet River	*Galena* with calcite		78 750	86, p. 40 T.
34	Illecillewaet (vicinity of)	*Galena* copper-pyrites and calcite	traces.	79 955	85, p. 28 B.
35	" "	Chiefly galena	traces.	71 521	86, p. 33 T.
36	" "	Quartz with *galena* and blende		142 187	85, p. 33 T.
37	" "	Galena		66 354	86, p. 34 T.
38	" "	Galena	trace	74 375	86, p. 34 T.
39	" "	Quartz with tetrahedrite, copper-pyrites, etc	trace.	248 616	87, p. 53 T.
40	" "	Galena, quartz		47 391	87, p. 53 T.
41	" "	Quartz, galena, tetrahedrite, blende, iron-pyrites	trace.	127 604	87, p. 54 T.
42	" "	Galena	trace.	57 664	87, p. 54 T.
43	" "	Galena and quartz	trace.	54 087	87, p. 54 T.
44	" "	Galena and quartz	trace	67 8 3	87, p. 51 T.
45	" "	Galena, tetrahedrite, quartz		186 104	87, p. 51 T.
46	" "	Galena with a little calcite		53 230	86, p. 39 T.
47	" "	Galena	traces.	64 859	87, p. 50 T.
48	" "	Quartz and galena		21 208	87, p. 51 T.

East Kootanie.

49	"Monarch Mine," Mount Stephen	Galena with a little quartz		5 104	1888.
50	Mount Stephen (Tunnel Mt.)	Galena	traces.	3 996	85, p. 24 B.
51	" " "	Galena with a little copper pyrites	traces.	4 010	85, p. 24 B.
52	" " "	Galena with a little copper pyrites	traces.	11 302	85, p. 24 B.
53	" " "	Galena with a little iron pyrites	traces.	3 281	85, p. 24 B.
54	Near Mount Stephen (Tunnel Mt.)	Galena		3 646	86, p. 40 T.
55	" " "	Galena		6 563	86, p. 40 T.
56	Otter-tail River	*Galena*, copper pyrites, etc		16 771	86, p. 39 T.
57	" "	*Galena*, *tetrahedrite*, copper-pyrites, quartz, etc		113 750	86, p. 39 T.
58	" "	Quartz, with *galena* and copper-pyrites	traces.	5 8 3	85, p. 24 B.
59	Near Otter-tail Station, C. P. Ry	Purple copper ore		19 687	87, p. 47 T.
60	"Granger's New Location," Jubilee Mountain	Quartz and dolomite with copper-glance and copper carbonate		39 375	1888.
61	"Wells Claim," Jubilee Mountain	Quartz with galena and iron-pyrites		5 104	1888.
62	"Wells Old Location," Jubilee Mountain	Copper glance, copper carbonates and hæmatite		22 571	1888.
63	Jubilee Mountain	Copper-glance with copper carbonates and dolomite		11 667	1888.
64	" "	Copper carbonates and ferric hydrate, a little copper-glance		2 187	1888.

No.	LOCALITY.	ASSOCIATED MINERALS.	GOLD. Ounces.	SILVER. Ounces.	Reference.
65	Spilimichene River, Purcell Range	*Galena* and iron-pyrites	traces.	8·094	85, p. 27 M.
66	"Golden Gate Claim," Carbonate Creek, McMurdo District	Quartz with *tetrahedrite*, galena, iron-pyrites	traces.	13·887	1888.
67	"Monitor Claim," Middle Fork Spilimichene.	Galena.	traces.	37·587	1888.
68	Toby Creek	Quartz with *galena*		88·646	1888.
69	North Fork Toby Creek	Coarse crystalline galena	traces.	66·354	1888.
70	Goat River, Kootanie	*Galena* with quartz and iron-pyrites		14·583	86, p. 40 T.
		Big Bend Region.			
71	"Taylor Lead," Big Bend	Quartz, with galena and iron-pyrites	0·175	0·641	86, p. 38 T.
72	"Little Bunting Lead," Big Bend	Quartz, with ferric hydrate and mica	1·925	0·175	86, p. 38 T.
73	Big Bend District	Quartz, with galena	traces.	43·750	86, p. 36 T.
74	"North Lead," Columbia Claim, McCulloch Ck., Big Bend	Rusty quartz, with galena	traces	16·975	86, p. 39 T.
75	"Silver King Mine," Big Bend	*Galena*, specular iron, quartz	traces.	21·875	86, p. 36 T.
		Omenica.			
76	"Champion Ledge," near Lost Creek, Omenica.	Quartz, with *galena* and pyrites.	trace.	19·723	78-79, p.24B.
77	"Arctic Circle Claim," Boulder Creek, Omenica.	*Galena*, iron oxide		128·078	78-79, p.25B.
78	" " " " " " (Assay by Johnson & Matthey.)			41·2	79-80, p.111B
79	"Arctic Circle Claim," Boulder Creek, Omenica. (Assay by G. W. Hopkins.)		trace.	40·81	79-80, p.111B
80	"Black Warrior Vein," Boulder Creek, Omenica (Assay by Johnson & Matthey.)			29·06	79-80, p.111B
81	"Black Warrior Vein," Boulder Creek, Omenica. (Assay by Riehn, Hemme & Co.)			93·00	79-80, p.111B
82	"Mammoth Ledge," Omenica (Assay by Thos. Price.)		0·1	32·40	79-80, p.111B
83	"Mammoth Ledge," Omenica (Assay by Riehn, Hemme & Co.)		0·814	91·13	79-80, p.112B
84	Vein near Manson Creek, 20 miles from "Dunkeld."	Quartz, with a little galena	trace.	8·971	75-76, p. 430
		Cassiar.			
85	"Acadia Claim," South Fork of McDame Creek, Cassiar	*Galena*, iron- and copper-pyrites, etc.		74·772	1888.
		Yukon District.			
86	Forty-mile Creek, Yukon District	Chiefly galena	traces.	38·646	

Interior Plateau Region.

87	"Carbonate Lode," Rock Creek (Laboratory of Survey)	Galena, somewhat oxidized	trace	64·166	
88	"Bonanza Queen," Tulameen R. (Laboratory of Survey)	Iron- and copper-pyrites, etc., with some galena, in quartz.	1·342	5·138	
89	Cherry Creek Mine	Quartz, with tetrahedrite, galena and zinc-blende	trace.	658·437	77-78, p. 50G.
90	" " "	" " " " " "	....	256·937	77-78, p. 51G.
91	Cherry Creek (found in sluice-boxes)	Galena	....	220·937	77-78, p. 50G.
92	North Fork of Cherry Creek	Quartz, with galena, pyrites, etc.	0·058	8·254	77-78, p. 50G.
93	"Hepburn Claims," near Stump Lake	Rusty quartz, galena	0·759	400·574	87, p. 38 T.
94	"Nicola Mining Company," Stump Lake.	Quartz, with *galena*, tetrahedrite, iron-pyrites, copper-pyrites, bornite	0·729	104·271	88, p. 37 T.
95	Stump Lake (vicinity of)	*Galena*, copper-pyrites, etc	traces.	20·339	87, p. 38 T.
96	" " " "	Quartz, with *galena*, etc	6·[illegible]	90·550	87, p. 39 T.
97	" " " "	Quartz, with tetrahedrite, galena, iron pyrites and blende	0·729	39·521	86, p. 35 T.
98	" " " "	Quartz with *galena* and iron pyrites	traces.	20·927	85, p. 35 T.
99	" " " "	" " " "	0·729	15·094	86, p. 38 T.
100	"Zeran Mine," Scotch Creek, Shuswap Lake	Quartz, with *galena*, iron-pyrites and copper-pyrites	1·969	17·063	86, p. 38 T.
101	" " " " " "	*Galena*, copper-pyrites, quartz and calcite	traces.	11·867	88, p. 34 T.
102	" " " " " "	Quartz, with *galena*	traces.	35·000	86, p. 34 T.
103	" " " " " "	*Galena* quartz	traces	46·667	86, p. 34 T.
104	"Home-Stake," Jamieson Creek, N. Thompson	*Galena*, iron-pyrites, quartz	traces.	10·208	86, p. 35 T.
105	"Silver King," Jamieson Creek	Rusty quartz, with a little galena	1·108	34·242	1888.
106	"Silver Queen," Jamieson Creek.	Rusty quartz, with small quantity galena and tetrahedrite	0·583	21·625	1888.
107	"Kamloops", Jamieson Creek	Rusty quartz, with a little galena	0·758	38·902	1888.
108	Mad River, N. Thompson, above Clearwater River	Rusty quartz, with galena and iron-pyrites	1·790	25·200	1888.
109	"Crown Point Ledge," left bank Cayoosh Creek	Quartz, etc	4·375	21·350	87, p. 49 T.
110	"Bonanza Location," right bank Cayoosh Creek.	Rusty quartz.	0·992	....	1888.
111	" " " " "	" "	0·991	0·058	1889.
112	South Fork Bridge River	" "	0·722	....	1888.
113	"Big Slide Mine," Fraser R. (assay at Nevada Metallurgical Works).	Rusty quartz, with carbonates of copper	dist. trace.	20·839	1888.
114	Fraser River, 25 m. above Lytton	Quartz, with pyrites, etc.	1·21	2·43	
115	Fraser River, 23 m. above Lytton	Tetrahedrite	trace.	[illegible]·833	1888.
116		Stibnite	trace.	2·187	1888.

Coast Ranges and Coast.

117	"Eureka Mine," near Hope	Yellowish decomposed veinstone	....	[illegible]·668	76-78, p. 478.
118	" " " "	" " "	....	271·46	73-74, p. 7.
119	" " " "		....	285·60	71-72, p. 66.
120	"Yale Creek Mine," Yale (three assays by J. H. Collins).	Iron-pyrites, blende and a very little copper-pyrites	traces.	13 to 70	
121	"Queen Mine," Yale Creek.	Chiefly blende and iron-pyrites	traces.	2·800	85, p. 28 H.
122	"Sterling Mine," Kokesaila River, Cowichan, V.I.	Galena and copper-pyrites in dolomite and quartz	traces.	9·844	79-80, p. 20H.
123	" " " " " "	" " " " " " "	traces.	17·323	79-80, p. 20H.
124	" " " " " "	" " " " " " "	traces.	8·021	79-80, p. 20H.
125	" " " " " "	" " " " " " "	traces.	5·104	79-80, p. 20H.
126	"Malaspina Copper Mine," Texada I	Copper-pyrites, iron-pyrites, etc	trace.	10·209	87, p. 55 T.
127	"Kitamat Ledge," Gardner Inlet.	Quartz, with copper pyrites, blende, galena	trace.	4·433	87, p. 54 T.
128	Six miles up Zymoets River, Skeena.	Quartz, with *galena*, copper- and iron-pyrites.	0·029	1·079	77-78, p. 51G.

COAL.

Discovery of coal near Suquash.

The discovery of coal in British Columbia antedated that of gold by more than twenty years, but did not at first produce any effect comparable with that of gold upon the history of the country. Dr. W. F. Tolmie was the first to make known the existence of coal, on the coast of the Province, in 1835. He was then stationed at the Hudson Bay Company's post, known as Fort McLoughlin, on Milbank Sound, and specimens of coal were brought to him by Indians from the north-east coast of Vancouver Island,—doubtless from Suquash. The steamer *Beaver*, belonging to the Company, arrived on the West Coast in 1836, and thereafter small quantities of coal were obtained for her, as well as for blacksmiths' use, from this place; being derived from natural outcrops on the beach. In the year 1849, a coal-miner was brought out by the Company, from Scotland, to more fully test the character of the coal on this part of the coast, and in 1851 a further number of miners and some necessary machinery were imported. Exploratory work by sinking and boring was prosecuted along the coast of Vancouver Island, between Port McNeill and Beaver Harbour, till 1853, but without resulting in any very notable discoveries.

Steamer Beaver.

Discovery of coal at Nanaimo.

Meanwhile, in 1850, the existence of coal at Nanaimo had been ascertained by Mr. J. W. McKay, and in the following year it appears that the most of the miners above referred to were transferred from the northern end of the island to that place. Work began in earnest at Nanaimo in 1852, and before the close of 1853, 2000 tons are reported to have been shipped, chiefly to San Francisco. The price of coal at Nanaimo was at this time $11 and at San Francisco $28 a ton. The Hudson Bay Company, under the name of the Nanaimo Coal Company, continued to work the mines thus opened till 1861, when these were sold to the Vancouver Coal Mining and Land Company (limited), by which they are still operated. The total shipments from October, 1852, to November, 1859, are returned at 25,398 tons.*

Initiation of mining.

Wellington mines.

The Wellington Mines, situated a short distance inland from Departure Bay, near Nanaimo, began to produce coal in 1871, and several hundred tons of coal were shipped in that year. This colliery, like the last, has since continued in active operation, with yearly increasing output, and from the various openings belonging to these two enterprises by far the greater part of the coal product of the Province is obtained.

Other mining enterprises.

In 1871 mining operations were in progress at Cowgitz, Queen Charlotte Islands, and several hundred tons of anthracite were shipped, but the work was not continued. In 1874 the Harewood Colliery, near

* For many details on the early history of the industry see Bancroft's Works, vol. xxxii., pp. 185, 565; also Annual Report Geol. Surv. Can., 1886, pp. 85 B., 69 B

Nanaimo, was opened. It had previously been worked on a small scale in 1864 and 1865. In 1875 the Baynes Sound Colliery, near Comox, was opened out to some extent, and preparations for mining and shipping coal were made, but from various causes, chief among which was the low price of coal, both this and the Harewood were closed down in 1877. In 1882 a shaft was sunk at the East Wellington Colliery, about midway between the Vancouver and Wellington mines, and a certain amount of coal has since been annually produced here.

Work at Comox.

With the exception of the Baynes Sound mine, the collieries above mentioned are all in the Nanaimo area, and the work done in the Comox area (except in the case of the Baynes Sound mine) was of the character of 'prospecting' and exploration only. In 1888, however, the serious development of mining work in the Comox area has been initiated by Hon. R. Dunsmuir at points situated between the old Baynes Sound mine and Comox Harbor, near the edge of the old "Union Claim." A railway, eleven miles in length, has been built to a suitable shipping place, and all preparations are being made for a large output of coal. This enterprise is known as the Union Colliery.

Progress of coal mining.

Since the initiation of coal-mining in the Nanaimo district, this industry has shewn a steady and satisfactory increase, and it has now attained large proportions, as evidenced by the subjoined table of output. Both the exports and the local consumption are constantly increasing, the latter being returned at 115,953 tons in 1888.*

TABLE SHEWING THE ANNUAL PRODUCTION OF COAL IN BRITISH COLUMBIA.†

Annual and total output of coal.

	Tons.‡
Coal mined at Suquash by H. B. Co. at various times between 1836 and 1852 (say)	10,000
Total coal shipped from Nanaimo, October, 1852, to November, 1859	25,398
1859 (Two months)	1,989
1860	14,247
1861	13,774
1862	18,118
1863	21,345
1864	28,632
1865	32,819
1866	25,115
1867	31,239
1868	44,005
1869	35,802
1870	29,843

*This includes the coal used at the mines.

† This table is I believe the first approximately complete statement of the annual output of the mines. I am indebted to Mr. S. Robins and Hon. R. Dunsmuir for the figures relating to years not previously published.

‡ These and other figures relating to coal, (except California imports on following page) refer to the ton of 2240 lbs.

			Tons.
1871	(Exclusive of Wellington Mines)	35,643*	148,456
1872	" " "	46,468	
1873	" " "	45,731	
	(Wellington Mines, 1871-73	(21,182)	
1874			81,547
1875			110,145
1876			139,192
1877			154,052
1878			170,846
1879			241,301
1880			267,595
1881			228,357
1882			282,139
1883			213,299
1884			394,070
1885			365,596
1886			326,636
1887			413,360
1888			489,301
	Total		4,355,221

Places to which coal is exported.

The exports of coal are chiefly to ports in California, includi 1888, San Francisco, Wilmington and San Diego. Sundry cargoes also shipped to Seattle, W.T.; Portland, Oregon; Alaska; Petropavl Hawaiian Islands; China and Japan. Coal has also been supplie ing the year to H.M. Navy, and to U.S. war and revenue vess well as to ocean mail steamers and other vessels calling for fuel.

Coal imports of California.

The standing of British Columbia coal in respect to the supp California, which constitutes the principal market, is well shew the subjoined statement of the sources of coal imported into that in 1888.†

	Tons.
British Columbia	345,681
Australia	271,612
England and Wales	126,167
Scotland	10,680
Eastern States (anthracite, etc.)	30,118
Total from coal mines on or near Puget Sound, W.T., including Seattle, Carbon Hill, Green River, Cedar River, Renton, Newport, South Prairie, etc	568,948
Coos Bay	47,015
Japan	13,808
oal from various sources, other than British Columbia, received at Wilmington and San Diego,(estimated at)	151,068
Total coal imports of California in 1888	1,565,097

* Including 685 tons Queen Charlotte Islands anthracite

† These statistics, and the places of destination of coal above, from Report of Minister o of B.C., 1888, p. 330.

Collieries now in operation. The following particulars for the various collieries in operation in Nanaimo and Comox, are derived from the Report of the Minister of Mines of British Columbia for 1888.—

Nanaimo Colliery.—Description of seams and workings.—South Field No. 2, worked by slope, seam, 6 to 10 feet thick. South Field No. 3, worked by shaft, seam, 5 to 10 feet thick. No. 1 shaft, seam, 5 to 12 feet thick. Total out-put 258,817 tons, 8 cwt.

Wellington Colliery.—Description of seams and workings.—Four working shafts, known as No. 3 pit, No. 4 pit, No. 5 pit, No. 6 shaft (sinking.) Three air shafts. Seams 6 to 10 feet thick. Total out-put 198,392 tons.

East Wellington Colliery.—Description of seams and workings.—Two shafts, known as Nos. 1 and 2 respectively. Total out-put 30,092 tons.

Union Colliery.—(Comox).—Description of workings.—One shaft, one slope, four levels, three tunnels, one air-shaft. Total out-put 2000 tons. (This mine is in process of being opened.)

Miners employed. The number of miners employed in the various Collieries in 1888, is as follows :—

	Boys.	Whites.	Chinese.	Indians	Total.
Nanaimo Colliery....	30	819	80	16	945
Wellington Colliery ..	10	585	100	None	695
E. Wellington Colliery	2	120	10	None	132
Union Colliery......	None	90	150	None	240
				Total miners employed in 1888.	2012

Wages. The wages paid to white miners at present, range from \$2 to \$4 a day, and the earnings of miners working on contract from \$3 to \$4·50. Chinese are paid at from \$1 to \$1·75, and Indians about \$2 a day.

Accidents. Several serious accidents from explosion of fire-damp have occurred in the history of the Nanaimo mines, viz.—Wellington Colliery, April 17, 1879, 11 lives lost; No. 1 Pit, Vancouver Colliery, May 3, 1887, 150 lives lost; No. 5 Pit, Wellington Colliery, Jan. 24, 1888, 77 lives lost.

Coal- and Lignite-bearing Formations of British Columbia.

Coal-bearing formations of the East and West. While the coals of Nova Scotia and of the eastern half of the United States are derived from the Carboniferous formation, of Palæozoic age, those of the Great Plains and Pacific Slope occur in association with much newer rocks, referable to the Mesozoic and Tertiary periods. Though in the western part of the continent rocks of Carboniferous age are known, and frequently appear in great thickness and covering extensive areas, they generally represent the

accumulations which have taken place in sea-bottoms, and consist largely of limestone; the swamps and marshy estuaries which afforded the conditions for the accumulation of vegetable matter elsewhere giving rise to the production of coal-beds, do not, so far as yet known, appear to have occurred during this period, in the West. Conditions of this kind, however, existed very generally in the West during certain stages of the Mesozoic and Tertiary, while rocks of these periods are developed on a comparatively small scale in the eastern half of the continent, and are there seldom found to contain coal.

Coal producing rocks of British Columbia.

In British Columbia, the formations known to contain mineral fuels of economic value, of the character of coals or lignites, are (1) the Cretaceous, or highest member of the Mesozoic, (2) the Tertiary. Respecting the latter, it is not yet clear whether all the coal- or lignite-bearing rocks included under it are referable to a single stage, but it is probable that at least most of them belong to the middle member of the Tertiary, or Miocene.

Fuels of the Cretaceous and Tertiary.

Rocks of Cretaceous age are developed over a considerable area in British Columbia, often in very great thickness, and fuels occur in them in important quantity, in at least two distinct stages, of which the lower and older includes the coal-measures of the Queen Charlotte Islands and those of Quatsino Sound on Vancouver Island, with those of Crow Nest Pass in the Rocky Mountains; the upper, the coal-measures of Nanaimo and Comox, and probably also those of Suquash and other localities. The lower rocks hold both anthracite and bituminous coal in the Queen Charlotte Islands, but elsewhere contain bituminous coal only. The upper have so far been found to yield bituminous coal only. The fuels of the Tertiary rocks are, generally speaking, lignites, but include also various fuels intermediate between these and true coals, which in a few places become true bituminous coals.

All grades of coal represented in British Columbia.

The series of mineral fuels thus presented by British Columbia alone, ranging from anthracites which compare favourably with those of Pennsylvania and Wales, to lignites, in which the original woody structure is still clearly preserved, and all embraced within the upper part of the Mesozoic and the Tertiary, is sufficient to disprove the theory at one time maintained, that the Carboniferous formation is the only one capable of yielding true coals. It is now generally acknowledged, that the character of such fuels depends essentially on the conditions of metamorphism to which they with the rocks containing them have been subjected, and only in secondary degree on their relative or absolute age.

Order of description.

It will, however, be most convenient, in presenting such notes as are here necessary on the various coal-bearing areas of the Province, to begin with those of the Cretaceous period, and this order

is further rendered appropriate by the relative importance of the fuels of that age. As most of the coal-fields are described at length in one or other of the reports of the Geological Survey, to which reference may be made, it is not intended here to enter into details with respect to them.

Principal Coal-fields (Cretaceous).

The most northern Cretaceous coal-field of the coast is that of the Queen Charlotte Islands. It extends over parts of Graham and Moresby Islands, on both sides of Skidegate Inlet, and is believed to run across the first-named island to the outer or ocean coast, though as yet only partially explored. Its area is considerable, and it has been in part geologically examined and mapped by the late James Richardson and by the writer.* In the vicinity of Skidegate Inlet, the Cretaceous rocks containing the coal are made up of the following sub-divisions, in descending order.— Queen Charlotte Islands.

	Feet.
A. Upper shales and sandstones	1,500
B. Conglomerates	2,000
C. Lower shales and sandstones	5,000
D. Agglomerates (of volcanic origin)	3,500
E. Lower sandstones	1,000
	13,000

The coal, so far as known, is confined to the base of the Lower shales and sandstones (C), and is proved by its associated fossils to be approximately of the age of that member of the Cretaceous formation known as the Gault.

At Cowgitz, in Skidegate Inlet, the Queen Charlotte Coal Mining Company, about 1871, constructed a wharf, houses, tramway, etc., and attempted to work the coal-seams, which have there the character of anthracite, but met with difficulties in following the seams, of which some portions were also found to be in a crushed and pulverulent state. Though these efforts were not attended with success, the work was not carried far enough to prove that the coal in this vicinity is not of a workable character. Further exploration appears to be fully justified by what is known of the place, and I believe that work of this character is at the present time in progress. The beds containing the anthracite here are almost vertical, and it is evidently on account of the disturbance and local alteration which it has suffered that the coal has passed into the condition of anthracite. The best seam found, had a maximum thickness of a little over six feet, while a second out-crop showed two feet five inches, and other less important out-crops also oc- Anthracite at Skidegate.

* See Report of Progress Geol. Surv. Can., 1878-79.

cur. Mr. Richardson was originally of opinion that several distinct seams exist at this place, but it now appears more probable that the various out-crops represent a single seam, repeated by folding.

Analysis of anthracite.

In composition, the anthracite of the Queen Charlotte Islands compares favorably with that from Pennsylvania. The following analyses by Dr. Harrington* were from samples collected by Mr. Richardson; No. 1 being from the six-foot seam; No. 2 from the so-called three-foot seam (2 feet 5 inches).—

	I.	II.
Water	1·60	1·89
Volatile combustible matter	5·02	4·77
Fixed carbon	83·09	85·76
Sulphur	1·53	0·89
Ash	8·76	6·69
	100·00	100·00

Bituminous coal on Ya-koun River.

Further north, in the same Cretaceous area, on the Ya-koun River, about midway between Skidegate and the head of Masset Inlet, a discovery has lately been made of bituminous coal of excellent quality. The bed is reported to be a very thick one, (18 feet), and several tons of the coal have been brought out, and tested with favorable results. Means of communication with the coast must, however, be provided before this deposit can be utilized. It is not certainly known whether this coal occupies the same position in the Cretaceous series as that of Cowgitz, but it is very probable that it does so.

Analysis.

The character of this coal is shown by the following analysis by Mr. Hoffmann.†—

Hygroscopic water	2·65
Volatile combustible matter	30·59
Fixed carbon	61·33
Ash	5·43
	100·00

Coal-fields of Northern Vancouver Island.

In the northern part of Vancouver Island, the Cretaceous coal-bearing rocks, though occupying but a small portion of the surface as compared with the older formations, have in the aggregate a considerable extent. The principal areas are those of Forward Inlet, Koprino and Koskeemo, all on the shores of Quatsino Sound, and of Suquash, on the north-east coast of the island. Of the Quatsino Sound areas, the only one which has yet attracted much attention is that referred to as the Koskeemo, which is situated on the upper part of Quatsino Sound. In this area, some exploration, both by sinking and boring, has at

* Report of Progress, Geol. Surv. Can., 1872-73, p. 81.

† Annual Report, Geol. Surv. Can., 1887, p. 17 B.

various times been carried out, though so far without resulting in the discovery of a coal-seam of a satisfactory workable character; the greatest thickness of good coal yet proved being about three feet only. The total length of this small Cretaceous area is about seven miles, its greatest probable width about two miles, and its approximate area, not including under-water extensions, about 5630 acres. Particulars respecting this area, with a map and details of borings, etc., may be found in the annual report for 1886.* The coal is bituminous, and is often of excellent quality. An analysis of a specimen, made in the laboratory of the Survey, gives the following result.— Koskeemo.

Analysis.

Hygroscopic water	1·05
Volatile combustible matter	34·38
Fixed carbon	54·01
Ash	10·56
	100·00

In the Forward Inlet Cretaceous area, coal is found at the head of the lagoon above Winter Harbour, but much disturbed locally and thin. It is not improbable, however, that boring operations on Winter Harbour would result in the discovery of better seams.† It appears likely that this area really connects eastward with that of Koprino, which extends along the north shore of the lower part of Quatsino Sound for seven or eight miles, and has a considerable width. Though no coal has yet been found in the last-mentioned area, it is larger than either of the others on Quatsino Sound, and as the beds are regular and little disturbed, it may, on proper investigation by boring, prove to be the most important.‡ Forward Inlet. Koprino.

The coal-field referred to as the Suquash area, extends along the north-east coast of Vancouver Island from Port McNeill to Beaver Harbour, a distance of fourteen miles. Its width inland must be considerable, and it probably also includes Malcolm Island, to the eastward, of which the surface is almost entirely covered by drift deposits. The original discovery and early exploration for and working of coal at this place are elsewhere referred to, (p. 80 B). The coal-seams as yet found here are quite thin, the thickest, at Suquash, not exceeding two feet. In consequence, however, of the flat-lying position of the beds along the shore, the exposures are poor, and but a small part of the thickness of the Cretaceous rocks is shown. The regularity of the beds and their extent are favourable to mining operations should thicker seams be discovered by boring. Particulars respecting this Suquash area.

* Part B, p. 90 B., *et seq.*
† See Annual Report Geol. Surv. Can., 1886, p. 83 B.
‡ *Ibid.* p. 87 B.

district are to be found in the report already referred to.* The coal found at Suquash is of very fair quality, as evidenced by the subjoined analysis.—

Analysis.

Hygroscopic water	5·03
Volatile combustible matter	41·51
Fixed carbon	46·52
Ash	6·94
	100·00

Relative age of the coals.

Respecting the stratigraphical position of these coal-bearing Cretaceous rocks of the northern part of Vancouver Island, it may be stated that the coals of Quatsino Sound generally, are believed to occur at the same horizon with those of Cowgitz, or in Series C, of the Queen Charlotte Islands section, while those of Suquash appear to belong to a higher stage.

Reports on Nanaimo and Comox.

The Comox and Nanaimo coal-fields are the most important in the Province, and the latter is that from which almost all the coal so far raised has been obtained. They have been in large part carefully examined by Mr. Richardson, whose various reports in the annual volumes of the Geological Survey for 1871–72, 1872–73, 1873–74 and 1876–77,† may be consulted for details.

Coal fields of Southern Vancouver Island.

The Cretaceous rocks constituting these coal-fields, border the south-western side of the Strait of Georgia, forming a belt of comparatively low, rolling or hilly country between the mountainous region of the interior of Vancouver Island and the coast. This belt, including the Cowichen area, reaches to within about eighteen miles of Victoria to the south-eastward, and to the vicinity of Cape Mudge in the opposite direction, with a length on the shore of about 130 miles. Its continuity is broken however at two points, near Maple Bay and near Nanoose Harbour, respectively, where the older underlying rock-series comes out to the shore. Beyond Cape Mudge, it runs inland in the same general north-westward bearing, but its extent in this direction is still unknown.

Stratigraphical relations.

The rocks accompanying the coals are sandstones, conglomerates and shales, being largely of the character of littoral formations, but also containing, (particularly in the shaly members of the series) truly marine fossils. They hold also in some layers abundance of fossil plants, and in appearance and degree of induration much resemble the older Carboniferous rocks of some parts of Eastern America. Coals of a workable character have been found only in the

* Annual Report Geol. Surv. Can., 1886, p. 61 B.

† In the last-named report, a general review of the geology is given. See also Annual Report Geol. Surv. Can., 1886, p. 16, B.

lower part of the Cretaceous series, which is represented with closely similar characters in the Comox & Nanaimo areas. The somewhat variable character of the Cretaceous measures as a whole is, however, shewn by the fact that Mr. Richardson found it necessary to adopt a different scheme of sub-divisions for the two areas, notwithstanding their general correspondence. The sections at Comox & Nanaimo are as follows, in descending order.— Sections at Nanaimo and Comox.

COMOX.	Feet.	NANAIMO.	Feet.
Upper conglomerates	320	Sandstones, conglomerates and shales	3290
Upper shales	776		
Middle conglomerates	1100		
Middle shales	76		
Lower conglomerates	900		
Lower shales	1000	Shales	660
Productive coal-measures	739	Productive coal-measures	1316
	4911		5266

The age of the Productive Coal-measures of Nanaimo & Comox is approximately that of the Chico group of California, in which, however in its typical locality, coals are not found.

The Comox area has probably a greater extent of productive measures and may eventually become more important than the Nanaimo. Mr. Richardson gives a number of carefully measured sections of the Comox area,* shewing its character along various parts of a line, which, following the direction of the out-crop of the beds, is about thirty miles in length. On Brown's River, furthest north, almost the entire mass of the Productive Measures is exposed, with a thickness of 739 feet 6 inches of beds. In this section, nine coal-seams occur, with an aggregate thickness of 16 feet 3 inches, the thickest bed being the lowest in the series, and averaging 7 feet. In a section of 122 feet at the Union mine, ten coal seams, with an aggregate thickness of 29 feet 3 inches occur, the thickest seam being 10 feet. This section represents only a small part of the Productive Measures. In a third section, on Trent River,—again embracing nearly the entire thickness of the Productive Measures,—thirteen seams are found, with an aggregate thickness of only 18 feet 1 inch, the thickest bed being 3 feet 8 inches. On the area of the Baynes Sound Company, in 220 feet 10 inches of measures, two seams of 6 feet and 5 feet 10 inches, respectively, occur. Comox coal-fields.

Mr. Richardson estimates the extent of country underlain by the Productive Measures at 300 square miles, without taking into consideration that which may lie beyond the shore, and not including the unexplored north-western extension of the field previously referred to. Extent and value of this field.

*Report of Progress, Geol. Surv. Can., 1872-3, p. 85 *et seq.*

Computing the total thickness of workable coal in the Union Company's property at a little over twenty-five feet, he calculates the quantity of coal underlying the surface at 25,000 tons per acre, or 16,000,000 tons per square mile for this part of the region.*

The operations now in progress in opening up mines in the Comox area have been alluded to on a former page. The principal seam which it is intended to work has been proved, by boring, to continue with good thickness for at least two miles in length.

Character of Comox coals.

The quality of the Comox coals is equal, if not somewhat superior to that of those of Nanaimo. They contain but a small percentage of water and the ash is also often very low. Several of them yield strong cokes. Proximate analyses of representative specimens are quoted in the table at the end of this chapter (p 98 R). The following analysis by Dr. B. J. Harrington may be quoted here, as probably representing the character of the main seam now being opened out for work. It is of that which Mr. Richardson named the lower or ten-foot seam, which shewed, where he examined it in the natural section, 7 feet 6 inches of clean coal.†—

	Slow coking.	Fast coking.
Hygroscopic water	1·70	1·70
Volatile combustible matter	27·17	32·36
Fixed carbon	68·27	63·08
Ash	2·86	2·86
	100·00	100·00
Coke	71·13	65·94

Nanaimo coal-field.

The area of the Nanaimo coal-field is estimated at about 200 square miles. There are at least two distinct seams of workable thickness in this area, but in consequence of folds and faults it is not easy to fix the equivalency of beds in its various parts. Three collieries are at present in operation here, the Nanaimo, Wellington and East Wellington. The works of the two first-named are on a very extensive scale, embracing numerous shafts and inclines, provided with good machinery, railways and wharves. In the Vancouver colliery, the principal workings are upon a seam which averages from six to ten feet in thickness. A second seam, overlaying the last, and separated from it by by 140 feet of sandstone, is seven feet thick. The seam worked in the Wellington colliery averages about nine feet in thickness, and yields a rather dry steam coal which does not afford a strong coke. The coal from the Vancouver colliery, on the contrary, gives a good coke and produces a large quantity of illuminating gas

*Report of Progress Geol. Surv., Can., 1871-72, p. 80.
†Report of Progress Geol. Surv. Can., 1872-73, pp. 38, 76.

Several proximate analyses are summarized in the table at the end of this chapter. That of the Wellington coal by Mr. C. Hoffmann, may be quoted here in full, as illustrating the character of the larger part of the coal shipped.—* Character of Nanaimo coals.

	Slow coking.	Fast coking.
Hygroscopic water	2.75	2.75
Volatile combustible matter	30.95	35.03
Fixed carbon	59.72	52.64
Ash	6.58	6.58
	100.00	100.00
Coke	66.30	59.22

Weight of one solid cubic foot.................82.64 pounds.

Evaporative power, 13·41 pounds of water (at 100° C.) per pound of fuel.

Besides the coal-fields above described, Cretaceous coal-bearing rocks are known to occur in several additional places upon the shores of Vancouver Island. Mr. Richardson describes the occurrence of rocks of the coal series at the head of Alberni Canal which opens into Barclay Sound, and coal has been found in other localities on the west coast in the vicinity of Clayoquat Sound. The interior of the island being yet comparatively unknown, even geographically, it is not improbable that a geological examination may bring to light coal areas in the valleys and tracts of low country which may prove to be important. A great part of the folding which the rocks have experienced is of post-Cretaceous date, a fact which renders it quite possible that outlyers of the coal-bearing rocks may be found folded into other synclinals besides these already known along the coast-line. Other coal-fields in Vancouver Island.

The character of the coals of Vancouver Island is illustrated by the analyses already quoted and by those in the comparative table (p. 98 B). Their superiority for all practical purposes to any others worked upon the Pacific Coast may be regarded as demonstrated, and is particularly evidenced by the higher price which they command, and by the fact that they are largely exported to California, and compete there successfully with coal produced in the United States, though handicapped by a duty of 75 cents a ton. General composition of Vancouver Island coals.

Dr. B. J. Harrington gives, as representing the average composition of the coals of Vancouver Island, as deduced from fifteen analyses by himself and Dr. T. S. Hunt, (chiefly from Nanaimo and Comox) the following.—†

* Report of Progress Geol. Surv. Can., 1882-84, p. 37 B.
† Report of Progress Geol. Surv. Can., 1872-73, p. 79.

Total volatile matter	30.33
Fixed carbon	60.23
Ash	9.44
	100.00

Coals of Puget Sound.

Though numerous analyses of picked samples from mines in the vicinity of Puget Sound, in Washington Territory, can be quoted, which compare favorably with those of Nanaimo, the fact remains that those actually shipped in quantity from Puget Sound points hold a distinctly inferior market value. This may in part be due to the large quantity of ash which these fuels often contain, a fact well illustrated in the tables of analyses in the U.S. Tenth Census.* On Puget Sound the greatest quantity of coal is shipped from Seattle and this ranks only as a lignite-coal affording no coherent coke. Of the following analyses representing the character of the Seattle coal, the first is quoted by Mr. Bailey Willis in the Census Report just cited,† the second is that given by Macfarlane.‡—

	I.	II.
Water	4·16	11·66
Volatile combustible matter	44·84	35·93
Fixed carbon	43·86	45·97
Ash	7·14	6·44
	100·00	100·00

Relative values of West Coast fuels.

As an impartial estimate showing the superiority of the Vancouver Island coals, the following table establishing the comparative value of these and other fuels for steam-raising purposes, by the War Department of the United States, will be interesting.

One cord (8 feet by 4 feet by 4 feet) of merchantable oak wood is there said to be equal to:—

	Pounds.
Nanaimo Coal (Vancouver Island)	1,800
Bellingham Bay Coal (Washington Territory)	2,200
Seattle Coal (Washington Territory)	2,400
Rocky Mountain Coal (Wyoming, &c)	2,500
Coos Bay Coal (Oregon)	2,600
Mount Diablo Coal, (California)	2,600

The following statement of the weights of steam obtained as the result of working tests from a cubic foot each of various fuels, at a slow rate of combustion, may also be referred to. The water to be evaporated had first been raised to a temperature of 212° F. The experiments

* U.S. Tenth Census, vol. xv, pp. 776-780.

† p. 781.

‡ Coal Regions of America, Third Edition, p. 509.

were made by the Chief Engineer of the U. S. Navy Yard at Mare Island.* —

	Pounds of Steam.
Nanaimo coal	372·64
Rocky Mountain, Monte Diablo, Coos Bay and Seattle	319·98

Though rocks of Cretaceous age occur on the mainland of British Columbia, and especially in the little-known northern portion of the Province characterize extensive tracts, they have not generally been found to contain coal. It may be stated, however, that specimens of good coal have been obtained from these rocks in the region of the Upper Skeena, (p. 150 B) on the western, or British Columbian side of the water-shed in the Rocky Mountains in the vicinity of the Crow Nest Pass, and in the country adjacent to the Peace River; and that it is probable that many further discoveries of the same kind still remain to be made. Cretaceous coals on the Mainland.

The coals of the Crow Nest Pass, first described by the writer in the Annual Report of the Geological Survey for 1885, (p. 69 B) have since attracted some attention, and have been to some extent explored and opened up. The Cretaceous basin or trough in which they occur is somewhat extensive, and resembles in general character those which occur on the opposite side of the Rocky Mountain water-shed, beyond the limits of British Columbia, in one of which the Cascade anthracite is included. The age of these Cretaceous rocks appears to be nearly the same with that of those of the Queen Charlotte Islands. By the 'prospecting' work which has lately been executed in the Crow Nest Pass, the existence of no less than fifteen workable seams is said to have been determined, two of which are reported as fourteen and thirty feet respectively in thickness (see p. 97 B). An analysis of coal from the thickest of these, (known as the "Jubilee Seam") by Mr. Hoffmann gave :—† Coals of Crow Nest Pass.

Hygroscopic water	1·79
Volatile combustible matter	25·45
Fixed Carbon	69·14
Ash	3·62
	100·00

On the Upper Skeena and its tributaries, Cretaceous rocks, again believed to be of the same age with those of the Queen Charlotte Islands, are extensively developed. One specimen of excellent coal has been obtained from them, at a place about eighteen miles up the Coal-bearing rocks of Skeena.

* Ex. Doc. No. 206. 2nd Session, 42nd Congress. p. 30.
† Annual Report Geol. Surv. Can., 1887, p. 12 T.

Watsonkwa, and impure coals have been noted in several localities. I is by no means improbable that an extensive coal-field exists here.*

Coals on Peace River.

To the north of the 54th degree of latitude, the eastern boundary o British Columbia follows the 120th meridian, and the Province there fore, includes a portion of the coal-bearing region of the Peace River Here, mineral fuels are known to occur at two distinct horizons, on being well down in the Cretaceous series, the other probably of Laramic age. Some of the fuels are true bituminous coals and others lignite coals. The limited amount of exploration yet carried out has not re sulted in the discovery of any very thick seams to the west of the 120th meridian, but the region is still, for the most part, practically unknown in detail.†

Coal and Lignite of the Tertiary.

Tertiary fuels.

The Tertiary rocks of British Columbia occasionally contain true coal, but more usually afford only brown-coal or lignite. Most of these rocks, as already noted, are assigned with probability to the Miocene period, but some of them, particularly those of the vicinity of the Fraser estuary, may be referable to the Laramie, to which stage the greater part of the coal- and lignite-bearing rocks of Puget Sound are now presumed to belong.‡

Fuels of Puget Sound, etc.

At Bellingham Bay, a short distance south of the International boundary, lignite was discovered about 1851, and in 1869, 20,500 tons were shipped to San Francisco, but the mines were closed down, owing to the inferior quality of their product, in 1878. Lignite-coals of the same age, or but little older, are now very extensively worked, however, in the vicinity of Seattle, and in the Wilkinson coal-field, further southward, as well as to the eastward, near the borders of the Puget Sound coal region, where the better classes of fuels previously adverted to occur. Some of these are, however, probably referable to beds older than the Laramie or of true Cretaceous age.

Fuels of Burrard Inlet and Lower Fraser.

The interest of these facts, in the present connexion, lies in the circumstance that the Tertiary or Laramie coal-measures of Puget Sound and Bellingham Bay are continuous north of the Interna tional boundary, and must underlie nearly 18,000 square miles of the low country about the estuary of the Fraser and in the lower part of its valley. Lignite has been found in association with these rocks at Burrard Inlet and other localities, and specimens of a fuel resembling true bituminous coal (and coking on the

* Report of Progress Geol. Surv. Can., 1879-80, p. 104 B.

† See Report of Progress Geol. Surv. Can. 1879-80, p. 134 B.

‡ See Report of Mr. Bailley Willis, U.S. 10th Census. vol. xv, p. 769. Also Dr. C. A. White on the Puget Sound Group, Am. Journ. Sci., vol. xxxvi. Dec., 1888

application of heat) have been obtained near the Fraser above New Westminster. The remarkably good specimen of coal from the River Chilliwack, of which an analysis, by Dr. Harrington, is given on page 99 of the Geological Survey Report for 1873-74, is probably from this series. The seams yet discovered are quite thin, but the low country underlain by the formation is deeply covered with drift and alluvium, and exposures are few; so that boring operations will be necessary before the existence or otherwise of workable seams of coal or lignite can be demonstrated in this region. Some particulars bearing on this problem, by Mr. Amos Bowman, may be found in the Summary Report of the Geological Survey for 1888 (p. 8), and notes on the more important localities are given at some length on a later page of present report (p. 147 R).* The thickness of Tertiary rocks of which more or less complete exposures occur, is estimated at about 3000 feet.

Value of these fuels.

As probably indicative of the character of some of the fuels to be found in the Lower Fraser region, the following analysis of that of Bellingham Bay may be quoted. †—

Hygroscopic water	8.39
Volatile combustible matter	45.50
Fixed carbon	33.26
Ash	12.66
	100.00

If fuels of this character, in beds of workable thickness, should be found to occur in the strata underlying Vancouver or New Westminster, the time has now arrived when they might be utilized on a large scale for local purposes, even though not so well suited as the coals of Nanaimo and Comox for purposes of export.

Lignites of the Coast.

Tertiary rocks holding lignite are found fringing other parts of the coast in greater or less width. They occur near Sooke,‡ and at various places on the south-west coast of Vancouver Island, and form a large part of the northern portion of the Queen Charlotte Islands. Particular references to the principal places in which lignite is found, are given on a later page (p. 145 R), but with the exception of the Lower Fraser region, none of these localities can be considered as of present importance, in view of the existence and accessibility of the superior fuels of the Cretaceous.

Tertiary coal- and lignite-bearing rocks of the Interior.

Rocks of Tertiary age are known to cover great tracts of the interior of British Columbia, and it can now be shown that in most places the horizontal, or slightly-inclined basaltic and other igneous flows of the

* See also Report of Progress Geol. Surv. Can. 1876-77, p. 188.
† Coal Regions of America, Macfarlane. Third Edition, p. 577.
‡ Report of Progress Geol. Surv. Can. 1876-77, p. 190.

interior plateau, are attached to, and form the latest rocks of the lignit or coal-bearing series of the Tertiary. From this fact, and the know relations of the beds in a number of localities, it is highly probabl that sedimentary Tertiary deposits underlie a great part of the are where only the later igneous rocks are seen at the surface, and in man places where extensive exposures of these Tertiary deposits occu more or less coal or lignite has been found in association with them Very roughly, in our present comparatively slender knowledge of th region, it may be estimated that this formation occupies between th 54th and 49th parallel of latitude, an area not less than 12,000 squar miles.

Nicola River and Coldwater.

In the Nicola Valley, near the mouth of the Coldwater, the occur rence of coal has been known for some years. The average of tw determinations, by Dr. Harrington, gave the following result.—*

Volatile combustible matter and moisture	36·065
Fixed carbon	61·290
Ash	2·645
	100·000

The seam from which the above specimen was derived, has a thick ness of nearly five feet, and is the lowest exposed. Other seams occu ring higher in the series approach lignites in composition. The rock containing these fuels are chiefly yellowish sandstones, which pa beneath massive volcanic accumulations, and are not well expose except in the vicinity of the mouth of the Coldwater, though the ove lying volcanic series extends along the Nicola to its confluence wit the Thompson, or for about thirty-seven miles. This locality is th most promising one yet found in connexion with the Tertiary of th Interior. Similar rocks to those here containing the coal are als found to extend far up the Coldwater, and though not satisfactoril exposed, are known to contain more or less coal.†

Kamloops and Thompson River.

The lower beds of the Tertiary are again found to contain coal at place within three miles of Kamloops. The fuel is of a bitumino character and of good quality, but the seams so far found are less tha a foot in thickness. Coal also occurs in the same position, about fort five miles up the North Thompson, but here again the seams yet di covered are thin.‡

* Report of Progress Geol. Surv. Can., 1876-77, p. 465. Another analysis made from specime subsequently collected is given in the table. (p. 98 R.)

† See Report of Progress, Geol. Surv. Can., 1877-8, p. 123 B.

‡ Summary Report Geol. Surv. Can., 1888, p. 4. Report of Progress, Geol. Surv. Can., 1877-7 p. 113 B.

Lignites or brown-coals are found abundantly in other parts of the Tertiary formation. On Hat Creek, near Marble Cañon, a bed of this material surpasses forty feet in thickness, and important deposits also occur on the North and South Forks of the Similkameen. The lignites and lignite formation of Quesnel are described in the reports of the Survey,* but the lignites here are, I believe, of no economic value. They are mixed with clayey matter, and are otherwise poor in quality; and are, apparently, the result of the rather tumultuous deposition of drift-wood and other vegetable matter, by rapidly-moving waters. Lignite of better quality, and apparently, in some instances at least, still resting in the locality where the wood producing it grew, is, however, found in other places, which are enumerated on later pages. Other localities of lignites.

These lignites do not, of course, compare favorably as fuels with the coal of the Nicola valley or with those of the Cretaceous, and would scarcely be of value, unless found in thick and accessible seams, and then only for local use or in the absence of other fuels. Comparatively little is yet known about their distribution, for though, as already stated, they probably underlie a great part of the basaltic plateau, the soft character of the associated beds allows them to be easily worn away, leaving hollows into which the basalts and other hard overlying volcanic rocks, readily crumbled by the weather, fall, concealing the lignite out-crops. Value and extent of lignites.

The subjoined table of proximate analyses gives, in summarized form, the results of a number of examinations of British Columbian coals and lignites. The references are to the published reports of the Geological Survey, where additional particulars with respect to these fuels may be found. The analyses selected are almost exclusively those of worked or workable seams. They shew, as already mentioned, that the fuels of the Province as a whole include all varieties, from anthracite to lignite, and that many of them are of a very high class. Table of analyses.

Analysis No 15 represents a fuel from a group of seams of the same character, lately discovered in the coal-bearing series of the Crow Nest Pass. The seams are reported to run from 4 to 7 feet in thickness. The specimen of which the assay is quoted, yields no less than 57·71 per cent. of volatile combustible matter by fast coking, resembling a true cannel in its behaviour on heating, and constituting a very excellent gas coal. Gas-coal.

*See Reports of Progress, Geol. Surv., Can., 1877-78 pp. 121 B., 130 B., 132 B.; 1871-72 p. 58; 1875-76 p. 257.

TABLE OF PROXIMATE ANALYSES OF COALS AND LIGNITES FROM THE PROVINCE OF BRITISH COLUMBIA.

	LOCALITY.	By slow or fast coking.	Hygroscopic water.	Volatile combustible matter.	Fixed Carbon.	Ash.	REFERENCE.
	(Cretaceous.)						
1	Cowgitz, Queen Charlotte Islands. "Six-foot seam"	F.	1.60	8.55	83.09	8.76	1872-73 p. 81.
2	Ya-koun River, between Skidegate and Masset Inlets. Queen Charlotte Islands	S.	2.45	30.59	61.53	5.43	1887 p. 17 T.
3	Coal Harbour. Koskeemo Quatsino Sound. Three foot seam	F.	1.65	[illegible]	54.01	10.76	1887 p. 16 T.
4	Suquash. N.E. Coast of Vancouver Island	F.	5.03	41.51	46.52	6.94	1887 p. 19 T.
5	Trent River. Comox. 3 ft. 8 in. seam	S.	0.97	26.09	66.42	6.95	1872-73 p. 77
6	Union Claim. Comox. 4 ft. 4 in seam	S.	1.34	28.11	67.72	2.83	1872-73 p. 77.
7	Union Claim. Comox. Lower seam, 7 ft. 6 in.	S.	1.70	27.17	68.27	2.86	1872-73 p. 76.
8	Baynes Sound Mine. Comox. Richardson seam	S.	1.18	34.13	48.51	16.18	1876-77 p. 468.
9	Wellington Mine, Departure Bay Nanaimo	S.	2.75	30.95	59.72	6.58	1882-84 p. 37 M.
10	Upper seam. Nanaimo	S.	29.30		55.75	14.95	1871-72 p. 99.
11	Newcastle Island. Nanaimo. Upper seam 3 to 4 ft	S.	1.57	31.77	58.03	8.63	1872-73 p. 80.
12	Newcastle Island. Nanaimo. Lower seam 4 ft	S.	35.49		52.57	11.94	1871-72 p. 99
13	Peter seam Crow Nest Pass	S.	1.79	25.45	69.14	3.62	1887 p. 12 T.
14	Jubilee seam. Crow Nest Pass	S.	1.89	24.88	68.86	4.37	1887 p. 14 T.
15	Seam X., Crow Nest Pass	S.	2.10	44.41	48.03	5.46	
16	Watsonkwa R., 18 miles above Skeena Forks	S.	0.85	39.67	57.51	1.97	1878-79 p. 14 B.
17	The Cañon. Peace River	S.	2.10	21.54	71.63	4.73	1875-76 p. 70.
18	Pine River, five miles above the Lower Forks, Peace River District	S.	2.45	27.87	54.58	15.10	1882-84 p. 89 M.
	(Tertiary or Laramie.)						
19	Near Chilliwack R., about 5 miles from Fraser R.	F.	35.73		63.86	0.41	1873-74 p. 99.
20	Mouth of Coldwater River. Five-foot seam	S.	4.45	29.68	57.16	8.71	1876-77 p. 466.
21	Mouth of Coldwater River. Fifteen-foot seam	S.	5.78	27.65	53.69	12.88	1877-78 p. 48 C.
22	Upper Nechacco, South of Fort Fraser. Four foot seam	S.	10.46	35.01	49.64	4.89	1876-77 p. 467.
23	Kobasgunko Stream South of Tanyabunkut L. Four-foot seam	S.	9.90	37.71	38.85	13.54	1877-78 p. 48 C.
24	N. Thompson. 45 miles above Kamloops	S.	2.84	33.56	52.03	11.57	1876-77 p. 466.
25	Hat Creek. Forty foot seam	S.	8.60	35.51	46.84	9.05	1877-78 p. 47 C.
26	Lewes River. Lat 62° 15′ Long. 136° 25′	F.	6.03	36.92	49.03	8.02	1887 p. 11 T.

IRON.

Utilisation of ores of iron.

Comparatively little attention has yet been given to iron-ores in British Columbia, in consequence of the impression that under the present conditions they possess little or no value. This is no doubt the case with those which are at a distance from the sea-board and remote from means of communication, but the time should not be far distant when such deposits as lie near navigable water, by which communication with the coal-fields may be had, can be utilized extensively in the manufacture of iron.

Character of ores.

Most of the ores of iron so far found in quantity, are magnetites, which occur in association with the older metamorphic rocks of the Province. Clay iron-stones are, however, of frequent occurrence in the coal series of Vancouver and Queen Charlotte Islands as well as in the Tertiary rocks of the Interior. These might, no doubt, in some cases, be profitably worked in conjunction with the coal-seams, as they occur in the same strata, and in some instances are even associated with the coal. The nodules vary in weight from a pound or less up to several tons, and Mr. Richardson says that at the Baynes Sound mine, a sufficient quantity might probably be obtained for the regular supply of a blast furnace.*

Texada Island

The only iron-ore deposits which have yet been worked, are those of the south-west side of Texada Island, the largest exposures of ore occurring about three miles north-west of Gillies Bay. Here the ore-mass is seen to be from twenty to twenty-five feet thick, and constitutes a somewhat irregular contact-deposit between limestone or marble and granite, thin veins of the ore being occasionally found reticulating the limestone. From this point to the northward, for nearly a mile, the ore is occasionally seen, and at one place there is a continuous exposure about 250 feet long and from one to ten feet thick. As regards mining and shipment, the ore is most favourably situated; while in the event of smelting operations being undertaken on the spot, there is an abundance of wood suitable for making charcoal on the island, and Comox Harbour, from which the coal of the Comox area may be shipped, is less than twenty miles distant.†

Analyses of ore

The ore is a magnetite of excellent quality. A partial analysis by Dr. B. J. Harrington, in the laboratory of Survey, shewed 68·40 per cent. of iron, with only ·003 per cent. of phosphorus. A partial analysis by Whitfield,‡ representing a lot of 600 tons, shews iron

* See remarks by Dr. B. J. Harrington, in Appendix iii, to Mr. Richardson's report. Report of Progress, Geol. Surv. Can., 1872-73, p. 82.

† For details see Report of Progress, Geol. Surv. Can., 1873-74, p. 99. Annual Report Geol. Surv. Can., 1886, p. 36 B.

‡ U. S. Tenth Census, vol. xv, p. 580.

65·71, phosphorus ·013. A more detailed analysis carried out by Messrs. P. C. Gilchrist and E. Riley, on specimens sent to the Colonial and Indian Exhibition in 1886, is as follows.*—

Iron	69·85
Manganese	trace
Siliceous matter	2·75
Sulphur	·06
Phosphoric acid	trace
Moisture	trace

Mining of the ore.

At the principal deposit of ore, situated as above described, a wharf has been built, and excellent arrangements made for mining and shipping. The ore is brought to the wharf by an incline nearly a quarter of a mile in length, from the point at which it is quarried out, about 250 feet above the sea-level. Considerable quantities of ore have been shipped from time to time to the works of the Puget Sound Iron Company, situated at Irondale, W. T. The Texada ore is there mixed with from one-ninth to three-tenths bog-ore, found near Irondale, and produces thus, or when smelted alone, an excellent quality of foundry pig.

The shipments in 1885, amounted to 190 tons; in 1886, 3941 tons; in 1887, to 1410 tons; and in 1888 to 7300 tons, valued at $18,400.†

East side of Texada.

Iron-ore deposits of the same character, and in considerable mass, are again found on the opposite or north-east shore of Texada Island, and very probably are more or less continuously developed along the contact of the granites and limestones elsewhere in the island.

Sooke.

Magnetic iron-ores of somewhat similar character occur in the hills to the east of Sooke Harbour, Vancouver Island. The deposits are on Sections 79 and 83, Sooke district, at a distance of about twenty miles from Victoria, near the coast, and well situated for shipment. The deposit is rather of the nature of a *stoke-work* than a true vein, but can be traced for some distance in a N.E.-S.W. direction, and in places shews from ten to twenty feet of nearly pure ore. The country-rock is a coarsely crystalline diorite (?), containing much hornblende. The following assays of various specimens of the ore give the percentage of metallic iron.—

Analyses of the ore.

Wm. Julian, San Francisco	72·40
Thos. Price, " "	51·80
" " " "	57·30
J. T. Bernige, Cornwall	48·90
" "	68·50
J. Kestle & Co., San Francisco	64·50
D. Wallace, Glasgow	61·50
" "	65·00

* Journal of the Iron and Steel Institute, 1886, p. 561.
† Tons of 2240 lbs.

Magnetic iron-ore occurs in considerable mass in the Queen Charlotte Islands, on the east side of the entrance to Harriet Harbour, Skin-kuttle Inlet. No attempt has, however, yet been made to utilize this ore. Occasional strings of pyrites traverse the ore, but it is, as a rule, remarkably pure. Specimens of an average character, collected by myself in 1878 and examined in the laboratory of the Survey, proved to contain 58·06 per cent. of metallic iron, while an exceptionally good fragment yielded 69·88 per cent.* Queen Charlotte Islands.

Very pure specimens of magnetite have also been brought from an island in the Walker group, in Queen Charlotte Sound, near the north end of Vancouver Island. These proved to contain 71·57 per cent. of metallic iron. Another specimen of a similar ore, comes from a deposit, which is reported to be extensive, on the north side of Rivers Inlet, about twenty-five miles up from its entrance. Numerous other localities of iron-ores will doubtless be found when sought for. Such additional occurrences on the coast as appear to be worthy of mention as well as those known in the inland portions of the Province, are enumerated further on. (See p. 151 B.) Other localities

COPPER.

Copper-ores are known to occur in many places, over the entire area of British Columbia. They were among the first to attract notice at several localities on the coast, and during the early years of the Province, various irregular and uncertain attempts were made to open up copper-mines, but none of these resulted advantageously to the promoters, and no copper mining has yet been initiated in British Columbia. Copper-ores in smaller quantity are very frequently found in little veins and joints in the altered volcanic rocks of the Vancouver series, extensively developed on the coast, as well as in the similar rocks of the interior of the Province. Hundreds of such localities have been observed, but only a small proportion of them can be considered at all promising. Such occurrences, however, should receive the attention of the prospector where met with, as the copper-staining of rock-exposures is sometimes the most obvious indication of the presence of ores of the precious metals. Occurrence of copper-ores.

It is further impossible to draw a distinct line between deposits which are to be regarded as ores of copper and those which hold sufficient gold or silver to entitle them to be classed as ores of the precious metals. In consequence of this fact, a number of metalliferous deposits which might with equal propriety have been included here, have already received mention in the pages devoted to the precious metals, to which reference should be made. Thus the Toad Mountain Copper-ores of the interior country.

*Report of Progress, Geol. Surv. Can., 1878-79, p. 54 B.

ores, though owing most of their value to silver, contain, in specimens assayed, from 25 to 47 per cent of copper. The ores of Jubilee Mountain, on the Upper Columbia valley, are again very rich in copper, and some of them in which the percentage of silver is low, must be regarded rather as copper-ores. Copper-pyrites also occur in some quantity in the Stump Lake ores and in those of several other places previously described. A deposit of copper-pyrites which appears to be of importance, is that owned by the B.C. Copper Mining Company, on the upper part of the South Similkameen. Another discovery of grey copper-ore, reported to be extensive, has lately been made between Rock and Boundary creeks.

Howe Sound.

In the vicinity of the coast, the copper deposit which has received most notice, is situated near the head of Salmon Arm of Jarvis Inlet and between that inlet and Howe Sound. This is owned by the Howe Copper Mining Company. The ore is chiefly bornite or purple copper and the deposit is not far from the coast, but at an elevation of 3000 feet above sea-level. It was discovered about 1874, and was worked at intervals between the years 1877–83, though rather with the view of developing the property than for the actual extraction of ore for shipment. Three levels have been driven on veins which are reported to be from 2 feet 6 inches to 3 feet 6 inches in width. Assays have shewn 58 per cent of copper and 50 ounces of silver to the ton. An assay of an average specimen, in the laboratory of the Geological Survey, shewed 40 per cent of copper. The veins traverse granitic rocks like those generally met with in the Coast Ranges.

Texada Island.

Some exploratory work has also been done on a copper deposit of promising appearance situated on the north-east shore of Texada Island, at the contact of marbles with an intrusive mass of granite. The ore is copper-pyrites, mixed with iron pyrites, and much of it is of very good quality. A specimen collected by myself and submitted to assay in the laboratory of the Survey, contained in addition to copper 10·20 ounces of silver to the ton.* The mining operations at one time attempted at Skincuttle Inlet, Queen Charlotte Islands, in search of copper, do not appear to have been warranted by the comparatively small quantity of copper-ore apparent there, and led to no good result.†

Queen Charlotte Islands.

Sooke.

A somewhat peculiar deposit of copper, upon which a shaft was sunk, was discovered near Sooke, on Vancouver Island in 1864. The copper here occurs in the native state, as thin leaves quite apparent to the eye, traversing green chloritic or diabase rock. A specimen subjected to assay, however, proved to contain but 1·02 per cent. of copper.‡

* Annual Report Geol. Surv. Can., 1886, p. 34 R

† Report of Progress Geol. Surv. Can., 1878-79, p. 53 B.

‡ Annual Report Geol. Surv. Can. 1886, p. 19 R.

Masses of native copper have been found from time to time in various parts of the Province, and nuggets and scales of the same material have been obtained in sluices-boxes in the course of gold-mining in a number of places, occasionally in notable quantity. Native copper to the amount of half a ton, obtained in this way from Quesnel River, near the Forks, was some years ago sent down to Victoria and sold there. None of these occurrences of native copper have yet been traced to their sources, but they may very probably be derived from rocks originally of volcanic origin in beds of which copper may be found to be distributed. Native copper.

In connexion with the mining of the precious metals, the out-put of copper from British Columbia is likely before long to become considerable, and it is only a question of time till copper-ores shall be worked as such in the Province. Copper out-put

Such localities of occurrence of copper as appear to be of interest are enumerated on pages 152 R to 155 R. In this connexion the list of assays of ores of the precious metals (pp. 76 R to 79 R) should also be referred to.

Lead.

As already explained, a large proportion of the silver-ores lately discovered and now in course of development in the Province, are argentiferous galenas, from which it is evident that so soon as these ores are extensively worked, the Province will become a lead producer to a notable extent. In consequence of the constant association of silver and lead, it has been thought best to include references to lead-ores, for the most part, under the head of silver. In the ores of Mount Stephen or Tunnel Mountain, on the Canadian Pacific Railway, and those of Hendryx Camp, on the east side of Kootanie Lake, may be mentioned as important occurrences of galena in which the value of the lead bears a considerable proportion to that of the contained silver. Both these deposits are now being opened up and shipments have already been made from the first-mentioned place to the smelter lately established at Vancouver. Deposits of galena which is not rich in silver, require to be situated within easy reach of means of transport or markets, before they can be assumed to possess any immediate value. Association of lead and silver.

Zinc.

Zinc blende is frequently found as an accessory mineral in the veins classed as those of the precious metals, as will be seen on reference to the table of assays on pp. 76 R to 79 R. No deposits of the ores of this Zinc blende.

metal which possess economic importance as sources of zinc have, ho
ever, yet been found in British Columbia.

ANTIMONY.

Stibnite

Several occurrences of stibnite or sulphide of antimony are know
in the southern part of the Province, which may prove to posse
economic value. Antimony also occurs in small quantities, in comb
nation, in a number of argentiferous ores, but can in such cases
regarded only as an impurity.

PLATINUM.

Localities yielding platinum.

The occurrence of platinum in association with placer gold is freque
in several parts of the Province, and is alluded to in connexion with t
enumeration of localities of gold-mining, in a number of cases. (S
pp. 115 R to 144 R.) The metal occurs in notable quantity in the region
the Upper Similkameen and Tulameen, in minute scales where t
gold is 'fine' but increasing in coarseness to small pellets a
nuggets in places where 'coarse' gold is found. Coarse grains a
pellets of platinum have so far been found only on Granite, Cedar a
Slate creeks, all entering the Tulameen on the south side. In certa
claims on these creeks, the platinum has been found to equal half t
weight of the gold obtained. It is estimated that from 1400 to 20
ounces of platinum were obtained in this district in 1887, and abo
1500 in 1888.

Character of the platinum and its value.

Though above referred to as platinum, the metal so named is alloy
with several other metals of the same class, of which osmiridium is t
most abundant. Specimens of the native platinum from Granite Cre
have been subjected to careful examination and analysis by Mr. Ho
mann, who states that the material "having the composition of the o
here in question would, at this present time, be worth from \$2·90
\$3·65 per ounce, troy, in the English market." Osmiridium is e
ployed, on account of its great hardness, for tipping the nibs of go
pens. "For this purpose it is necessary that it should be in the for
of natural grains, and these are very carefully selected, the requir
ments being that they should be solid, compact and of the proper si
and shape." This was not, however, found to be the case with th
present in the platinum from Granite Creek.*

Probable source of the platinum

Platinum has very rarely been discovered in veins or otherwise in i
original matrix, and in the Ural Mountains, whence the greatest qua

* Annual Report Geol. Surv. Can., 1886, p. 5 T.

tities are obtained, it is almost always found, as in the cases above cited, in association with gold-bearing alluviums. In the northern part of the Government of Perm, however, it has been noted in a few places with little or no accompanying gold, and it then appears to be derived from rocks consisting of serpentine and peridotite with talcose and chloritic schists and chromite. While there is a notable abundance of greenish, chloritic, and hornblendic schists and diabase rocks, (resulting from the metamorphism of old volcanic rocks) in the Tulameen and upper Similkameen region, and chromite and magnetite are here found in the workings in association with the platinum and gold, no peridotite or serpentine is actually known to occur. The circumstances in connexion with the occurrence of the 'coarse' platinum appear to point to the vicinity of an important mass of intrusive diorite as its point of origin. A great part of the associated magnetite is certainly derived from veins in this rock, and it seems not improbable that the platinum, and possibly also a great part of the gold of this district, may occur in scattered grains in this intrusive mass, (compare p. 128 R). Very little vein-stuff occurs in the gravels with which the platinum and gold of this region are associated.

Importance deposits.

It may be added here, that the platiniferous region of the Upper Similkameen and Tulameen, is the most important as yet discovered in North America. Mr. David T. Day states, that owing to the rise in price of refined platinum, considerable enquiry for the crude material occurred in 1887, and that in consequence of enquiries for that material instituted in the West, a total quantity of 448 ounces of platinum was purchased, this being set down as the entire yield of the United States. Part of this platinum came from various places in Oregon, but a portion is stated to have been derived from British Columbia, and doubtless, from the region here referred to, as shipments were not made from other places in which very small quantities only are met with. The average price paid for this crude platinum was, according to the figures given, about $4 an ounce.*

MERCURY.

Occurrence of cinnabar.

It has already been stated (p. 12 R,) that no important deposits of ores of mercury have yet been discovered in British Columbia. Some pieces of cinnabar have been found in several places, and on the Homathco River and Wapta (Kicking Horse) River this ore has been found in place, but apparently in neither locality in workable quantity. Mercury is mentioned as appearing in globules in the native state in some parts of the silver-ore of Silver Peak, near Hope, and it also occurs in combination with silver in the mineral arquerite previously noted.

* See Mineral Resources of the United States, 1887, pp. 2 142.

Arsenic.

Native arsenic. Native arsenic has been noted in one localtity, where it appare occurs in considerable mass, to the west of the Fraser River, a s distance above Lillooet. Elsewhere it is known only as a relati unimportant constituent in mixed ores.

Molybdenum.

Molybdenite. Molybedenite, or sulphide of molybdenum has been observed number of localities, but usually in small quantities only. T localities are situated for the most part in or near the Coast Ran Fine specimens have, however, been brought from the head of S zum Creek, west of the Fraser, which may indicate the existence deposit of economic importance.

Structural Materials.—*Building Stones.*

Supply of building stones. Such demand as has up to the present time occurred for building-s in various parts of the Province, has, as a rule, been satisfied wit much difficulty. It may be stated, however, as a somewhat pec feature, that over a great part of the Interior Plateau, the rocks been subjected to so much stress, and have been so completely cru and jointed in consequence of disturbance subsequent to the perio their partial or complete induration, that homogeneous stone, suit for masonry, is there notably scarce over considerabe areas.

Building stones of the coast. On the coast, building stones of excellent quality are met with in greatest abundance. These consist of granites and granitoid rock the Coast Ranges, and of sandstones and freestones of Cretaceous Both varieties may frequently be quarried at the water's edge with cellent facilities for shipment. Marbles, suitable for purpose of struction, are also found in several places, and in situations equ advantageous.

Victoria. At Victoria, a considerable quantity of good grey granite has obtained from the large travelled boulders, which at one time existe abundance in the vicinity of the city. Granite from the Ne Island quarry, Jarvis Inlet, has also been employed to a limited ext and Cretaceous sandstone from the vicinity of Nanaimo and elsew has been used in considerable quantities. The greater number of permanent structures are, however, built of brick, of fair quality, w is manufactured from a sandy clay, of marine origin, which overlies oulder-clay to a depth of from five to fifteen feet.

In the construction of the dry-dock at Esquimalt, the greater part of the stone employed was a greenish-grey sandstone of Cretaceous age, quarried extensively for the supply of this work, on Admiralty or Salt Spring Island. For portions of the work requiring greater strength, the granite of Nelson Island was used. Stone used in dry dock

For Vancouver, the principal building-stone is a very excellent grey granite, quarried on the North Arm of Burrard Inlet, at the water's edge, and lightered thence to the city. Brick is, however, extensively used here and at New Westminster. It is manufactured from clays similar to those of the neighborhood of Victoria, which have like those there used, a red colour. Vancouver.

The granites so far met with in favorable positions for quarrying in the vicinity of the coast, are generally grey in colour and more or less hornblendic. Some excellent stones of a pinkish-grey colour (like that of Nelson Island) also occur. Most of these granites and granitoid rocks are susceptible of a high polish. No distinctively red granites of good quality have been observed in mass or quarried. Granites.

The quantity and quality of the granites of the coast region is such, taken in connexion with their accessibility, as to suggest that they may ere long become the basis of an important industry, and that they will be quarried, not alone for home use, but for export to other places less favorably situated in respect to building-stones.

The greater facility with which the sandstones of Cretaceous age may be worked, renders them more appropriate for certain classes of buildings, and from a commercial point of view, they may be regarded as at least equally important with the granites. Among the coal-bearing rocks of Newcastle Island, Nanaimo, there are beds of brownish-grey sandstone, which afford excellent material for building and flagging. The upper beds are of the best quality, and it was from one of these that Mr. E. E. Emery, of San Francisco, obtained the stone for the construction of portions of the mint in that city. Blocks for pillars were taken out, which, after dressing, were twenty-seven feet six inches in length, and three feet ten inches in diameter. Flag-stones, with even surfaces, as much as ten feet square, have also been obtained, and are easily quarried. These sandstones have also been employed for the manufacture of grindstones to a limited extent, and some beds are believed to be well suited for this use. Sandstones.

The marbles of Texada Island and of other localities easily reached by sea, must also be regarded as possessing considerable value for ordinary building purposes. Several of these take an excellent polish, and are already in use, to a small extent, for the manufacture of monuments. The known marbles generally range in colour from grey to white, and include some very handsome mottled and clouded varieties. Marbles.

So little enquiry has, however, yet been made for marble, tha highly probable that many additional varieties remain to be fou

Building-stones of the interior.

Building-stones situated at a distance from the coast or from t of railway must, of course, be considered as possessing no p value. On that part of the railway which traverses the Coast R as far inland as North Bend, grey granites of the kind just not well situated for quarrying, are of frequent occurrence. Gran this character, obtained in the immediate neighborhood, were em in the construction of the piers of the great cantilever bridge the Fraser. Further inland, building-stones of good quality are met with near the railway, till the Shuswap Lakes are reached would appear that the silts abundantly developed in banks alo rivers, and forming the latest deposit of the glacial period, a suited for the manufacture of brick.

Quarries.

On a subsequent page a number of localities are enumerated in quarries have been opened, or which present all the conditions sary for the successful quarrying of good stone. In this list, prominence is given to the southern part of the coast of the P and to places on the line of railway. It may indeed be state localities not included in one or other of these categories are o as, with rare exceptions, such cannot be regarded as of any imm value.

Slate.

The existence of slate of good quality and easily fissile in lar faces, has not, so far as I am aware, yet been proved in any the province of British Columbia, though reported in several particularly at a place six miles and a half east of Golden, on th Ry. line.

Ornamental Stones.

Materials susceptible of high polish.

Under the head of ornamental stones, such materials as are s ble of employment in architecture for decorative purposes classed. These would include many of the granites and gr rocks susceptible of a high polish, together with the marbles, pre referred to. Porphyries, diorites, etc., may also be included he these are found in great variety of colour and texture in vario of the Province. Slabs of a porphyrite-breccia obtained by M ardson in the Ballinac Islands were found to take a very fair pol few experiments have yet been made toward the utilization materials. The serpentines which occur in many places in the of the Province, can scarcely be regarded as of value for su poses, as most of them are too much jointed and disturbed to blocks or slabs of useful size, free from flaws. They differ respect very markedly from the serpentines of the Eastern To of the province of Quebec, some of which afford excellent verd-

Limes and Cements.

Importance attaches also to places in which limestone of good quality and well situated for the manufacture of lime and its shipment occurs. Victoria is at the present time chiefly supplied with lime from San Juan Island, W. T., and from Saanich; for though limestone occurs in several places in the immediate vicinity of the city, it is generally of an impure and siliceous character. Vancouver also derives the greater part of its supply from the San Juan quarries. In this connexion, I think attention cannot be too strongly drawn to the fact that pure and excellent limestone, which often assumes the character of marble, occurs in the northern part of Texada Island in quite unlimited quantity, and that this island is scarcely less accessible by water than San Juan, and possesses the additional advantage of proximity to the coal-fields of Nanaimo and Comox. There appears to be an excellent opening here for an important industry. The best places for work and shipment on Texada Island are Marble Cove, on Malaspina Strait, three miles from the north end of the island, and Marshall Bay, at the northern extreme of the island. Sources of supply. Opportunity for work.

As entire groups of mountains and hills to the east of the Coast Ranges are frequently composed of limestone, it is naturally impossible to enumerate localities of occurrence of this material generally throughout the Province. It has, however, been considered advisable to mention, on a subsequent page, a few places which from their situation are regarded as of importance, and which have come under my own notice. Great abundance of lime.

Hydraulic limestone, useful for the manufacture of cement, has not yet been found in the Province, but it must be admitted that in consequence of the very moderate demand which has so far occurred for such material, it has been but little sought after. Nodular calcareous rocks, containing a certain amount of clayey matter, such as occur in the Cretaceous and Tertiary series, sometimes in considerable abundance, appear to be the most probable source of supply of cements, and deserve to be looked after and experimented with in this connexion. Hydraulic cement.

It is highly probable also that some of the volcanic tuffs of Tertiary age, met with particularly in the region of the Interior Plateau, may be found of value for use in the manufacture of cements in a similar way to the *trass* of the vicinity of Andernach and elsewhere on the Rhine, or the Pozzuolana of Naples. These materials are merely ground and mixed, without being calcined, with a certain proportion of quick-lime, and are then found to possess excellent hydraulic properties. Trass.

Most of the tuffs actually known to occur in quantity in the Province, are situated at some distance from the line of railway, but it is possible

that some of the tufaceous rocks of the vicinity of Kamloops Lake might be employed in the manufacture of cement. On the coast, I have observed a considerable deposit of material almost identical in appearance with the trass of the Rhine, at Lawn Hill, near the entrance to Skidegate, Queen Charlotte Islands.* Other localities of similar material may also yet be found on the Coast, and should they prove to afford good hydraulic cement, they will possess great value for the construction of wharves, etc., where wooden structures are rapidly destroyed by the teredo.

PRECIOUS STONES.

Absence of gem stones.

Gems of the more valuable species, such as the diamond, sapphire etc., have not been as yet found in any part of British Columbia, and taking into consideration the great amount of placer gold-mining which has occurred, their apparent absence must be considered as rather remarkable; though this is perhaps due to want of observation on the part of the miners. Garnets are of frequent occurence, both imbedded in the crystalline rocks and found loose in sluice-boxes in the course of gold-mining, but none have yet been observed sufficiently free from flaws, or of size or colour such as to render them valuable for jewellery.

Agates.

Agates and chalcedony are very often found in association with th volcanic rocks of the Tertiary, and on the shores of the northern par of the Queen Charlotte Islands, as well as along some of the rivers an lakes of the interior, these may be collected in considerable numbers i the form of rolled pebbles. Jasper also occurs in some places in the Ter tiary rocks, and the Indians occasionally employed this material an agate in the manufacture of arrow- and spear-heads. It is more com mon, however, to find arrow-heads in the interior of the Province composed of black cherty quartzite, which is there abundant in man places. In the Northern Interior the Indians of the Tinné stock ofte

Obsidian.

used obsidian or volcanic glass for the same purposes, the most notabl locality for this material being the mountain named Beece or Anahim Peak, in the upper Blackwater country.†

Opal.

Siliceous deposits of the character of 'wood opal' are found wher siliceous springs have issued during the earlier stages of the Tertiary particularly in the vicinity of Vermilion Forks on the Similkamee and near Dropping-water Creek, about two miles north-west from th head of Stump Lake. At the last-mentioned place, opaline silica an hyalite have been observed, filling cavities in a slightly cavernou trachyte, which occurs in great mass. Some specimens closely ap

* Report of Progress, Geol. Surv. Can., 1878-79, p. 85 B.
† Report of Progress, Geol. Surv. Can., 1876-77, pp. 73-75.

proach precious opal in character, and the locality appears to be worthy of further examination, as the rock is identical in character with that yielding the precious opal in Hungary and elsewhere.

Specimens of very beautiful blue sodalite, are found in abundance in the vicinity of Ice River, a tributary of the Beaver-foot, in the Rocky Mountains. The mineral closely resembles lapis-lazuli in appearance, and would possess considerable value as an ornamental stone for jewellery, etc. Closer search than we were able to make would probably lead to the discovery of even larger pieces than those found by us, some of which, however, were several inches in diameter. The mineral occurs in connexion with an intrusive mass of nepheline-syenite.* Sodalite.

Jade or nephrite was highly prized by the Indians of the coast of British Columbia and Alaska for the manufacture of cutting implements of the nature of adzes or 'celts.' It is frequently found in the form of such implements, varying in colour through various shades of green to brown, in the purer varieties quite translucent, but when less pure becoming clouded and opaque. I have elsewhere shown reason for the belief that this mineral occurs in place in the vicinity of the Fraser River, and have since found rolled pieces of it on the Lewes branch of the Yukon.† Some specimens constitute handsome ornamental stones. Jade.

Specimens of lignite from some beds of the Tertiary resemble jet in appearance, but are usually too brittle to be employed for purposes of ornament. True jet may, however, be looked for in assocaition with these rocks. Jet.

Mineral resin in small drops and patches is of frequent occurrence in some of the Tertiary and Cretaceous coals, and a small specimen of true amber was found in the possession of the Indians in the Queen Charlotte Islands and said to have been derived from the west coast of these islands Amber.

* Annual Report Geol. Surv. Can., 1885, p. 124 B. Trans. Royal Soc. Can. vol. iv, Section iii, p. 81.

† Canadian Record of Science, vol. ii, No. 6, 1887. Annual Report Geol. Surv. Can., 1887, pp 38 B, 147 B.

MISCELLANEOUS MINERALS.

Minerals not discovered.

No single specimen of *tin* ore has yet been found in any part
Province nor have *nickel*, *cobalt*, *manganese* and *chromium* been disc
in anything approaching workable quantity. *Graphite* or *plum*
known, but not apparently in useful deposits. *Gypsum* deposit
not been found, and this mineral appears only in the form of s
crystals in certain shales and clays. Red and yellow *ochres* oc
several places, making, sometimes, a considerable shewing, but
tempt has been made to utilize them so far. *Baryte* or heavy-s
pears only as an accessory mineral, and no deposits of *rock-sal*
native sulphur have been discovered. *Tripolite* or diatomaceous
appears forming certain layers in the Tertiary clays on the Black
and may probably elsewhere be found in like situations, and in th
of some of the very numerous lakes and ponds. *Kaolin* or chi
has not been found. The occurrence of *asbestus* is noted elsewhe
apparently in small quantity only, though the abundance of serp
leads to the belief that veins of chrysotile or serpentine-asbestu
be looked for with some probability of success It is also very
able that valuable deposits of *mica* may be found in some
granitic districts, and some localities of a promising characte
already been observed. *Fire-clays* may be expected to occur
Cretaceous and Tertiary coal-bearing rocks, but so far as know
have not yet been sought for or tested. *Petroleum* is not
in the Province, and though rumours were current some years a
its occurrence in the northern extension of the Comox coal-field
could not be substantiated. Tarry, bituminous matter is, ho
found oozing out in several places on the Tar Islands of the Quee
lotte group.

Ochres. Tripolite. Asbestus. Mica. Petroleum.

MINERAL AND THERMAL SPRINGS.

Hot Springs.

Saline or mineral springs are known in a number of widely sca
localities within the limits of the Province. Several of these ar
as hot springs, and it is probable that all the thermal waters c
notable quantities of saline water. Springs characterized
abundance of common salt are known at Nanaimo and Admir
Salt Spring Island, but the flow of these is not so copious
strength of the brine sufficient to warrant a belief in their ec
importance. Of the other springs, some of which may possess
peutic value, the only one so far utilized to any considerable ex
that known as "St. Alice's Well," at the lower end of H
Lake. A hotel has been built at this place and it is frequen

Salt Springs. Mineral Springs.

a health resort, accommodations for bathing, etc., being provided. There are in the Selkirks and elsewhere a number of springs locally known as "Soda Springs," which are highly charged with carbonic acid gas, and some of which are reported to be excellent as beverages.

In the dry parts of the Interior Plateau region, many more or less saline pools and lakes occur, but the salts in these are usually those resulting merely from the local evaporation of ordinary surface waters. There are also, in the same region, many small saline springs which issue from the superficial deposits or soft Tertiary rocks. These appear generally to contain sulphates of soda, magnesia, etc., and possess no economic or therapeutic importance.

Such notes on individual springs as appear to be of importance are given in connexion with their enumeration on page 162 B.

ANNOTATED LIST OF LOCALITIES OF MINES AND OF KNOWN OCCURRENCES OF MINERALS OF ECONOMIC VALUE IN THE PROVINCE OF BRITISH COLUMBIA.*

GOLD (PLACERS).

Though many of the undermentioned placer-deposits are now abandoned, it has been endeavoured to make the list as complete as possible, for the purpose of indicating the localities of probable occurrence of auriferous veins.

Fraser River.

It is at this date difficult to correctly enumerate and place the principal auriferous 'bars' of the Fraser. The greater part of the work upon these occurred in 1858 and 1859, the first years of the gold excitement. Many bars were then named and worked for a short time only, and of others which were occupied for a longer time and yielded a large quantity of gold, it is not always possible to obtain any statistics or facts of a trustworthy character. The best authority for the names and positions of the more important bars, as far up as Lytton, is the Admiralty map of Vancouver Island and Adjacent Shores of British Columbia, No 1917, corrected to December, 1886. Much information is also contained in Vol. XXXII. of Mr. H. H. Bancroft's works, which that author has been at great pains to collect from innumerable sources of varying authenticity. From statements quoted in Mr. Bancroft's work, the greater part of the details of yield of various bars, given below, has been selected. The names of bars of which the position relatively to the others is not accurately known, are enclosed in parentheses.

The various bars are arranged as far as possible in order, following up the river.

BARS BELOW HOPE.—All these yielded very fine gold only.

Maria Bar.—Twenty-five miles below Hope, near mouth of Chilliwack River. This was the lowest bar on the Fraser which paid for work.

(Several bars of which the names are not known.)

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* Unless otherwise specified, the references throughout this list of localities are to the Reports of the Geological Survey, of which the dates are given, but not the full titles.

Hudson Bar.—A ditch a mile long here in 1859. Earnings, $8
a day.

Cornish Bar.—First known as *Murderer Bar*, four miles below
In 1860, fifteen men were employed here, making from $3 to $4
This and other bars in the vicinity averaged as minimum earnin
to $10 in 1858.

Bars between Hope and Yale.—Some of these bars yielded
results in 1858 and 1859. In 1865 Chinamen were still making
$2 to $5 on them.

American Bar.—

(*Union Bar.*)—Two miles above Hope.

St. Clara Bar.—

Posey Bar.—

(*Cameron's Bar.*)—On this bar nineteen men are reported to
made $75 a day each for three weeks. This was a mid-stream b

Emory's Bar.—Average earnings, $6 to $8.

Texas Bar.—Yielded as high as $15 to $40 a day to the hand.

Hill's Bar.—In 1858, the earnings are stated to have average
a day to the hand. Another authority places the earnings at
$2·50 to $25. Eight companies were making from $15 to $40.
men on one occasion sluiced out gold to the value of $1000 in six
Ten claims, each 26-foot frontage, produced $30,000 in less than
months. (See p. 26 R)

Yale.—Bars here produced $15 to $20 a day per man. Sl
yielded $25 to the hand. Mining still in progress in 1888.

Bars between Yale and Lytton.—The bars between Yal
Boston Bar are reported to have given an average yield of $12 a
the hand, early in 1858.

Sailor Bar.—Five and a-half miles above Yale. In 1858 yielde
to four ounces a day to the hand.

Wellington Bar.—

Washington Bar.—

Spuzzum.—(According to Brancroft, there were between Yal
Spuzzum, named, in addition to the above bars—Pike, Madison, S
boat, Humbug, Surprise and Kelly bars.)

Chapman's Bar.—

Dutchman's Bar.—

Cross Bar.—

Siwash Bar.—

Big Cañon.—

Nicaragua Bar.—In 1859, five men are stated to have taken ou
to the value of $118 in one day here.

Tehama Bar.—

Island Bar.—

Boston Bar.—Mining begun in 1858. Bench mining in progress in 1888.

Yankee Bar.—

Fargo Bar.—

Mariner's Bar.—

Rancheria Bar.—

New Brunswick Bar.—

Lytton.—Mining begun in 1858. In January, 1859, 100 men at work in this vicinity averaging $8 a day.

BARS BETWEEN LYTTON AND FOUNTAIN.—In 1859, earnings on these bars from $8 to $100. Averaged earnings stated at $9 to $10.

Mormon Bar.—In 1858 one rocker produced gold to the value of $830 in eight days. Another $800 in twelve days.

Spindulum Flat.—Yielding gold to the value of $8 to $10 to the hand in May, 1859.

McGoffery Dry Diggings.—Rich benches. Nuggets valued at 50 cents to $12 found.

Foster Bar.—A party in July, 1858, obtained here, with rockers, in six hours, 'three to five ounces to the man. In May, 1865, miners reported to make, with rockers, $3 to $8 to the hand. Sluice company producing at the rate of $8 a day to the hand.

Willow Bank.—Nuggets weighing four to six ounces found here.

Great Falls.—Reported at one time as yielding $10 to $30 a day to the hand in coarse gold. Nuggets weighing six ounces found.

Lillooet.—(Known as "Coyoosh" in 1858 and 1859.)

French Bar. (Just above Lillooet). In 1859 yielding $4 to$6 with rockers; $8 to $12 by sluicing.

Robinson's Bar.—In June, 1858, 100 miners making, at first, $80 to $90 a day each. Yield soon fell to $5 to $6.

Horse Beef Bar.—In 1859 yielding $2 to $6 a day to the hand.

Upper Mormon Bar.—Opposite Fountain. The diggings here and in the vicinity of Fountain were regarded as among the best. In 1858 five rockers were averaging $47 each a day. There were also good, dry diggings, thirty yards away from the river.

BARS BETWEEN FOUNTAIN AND ALEXANDRIA.—

Day Bar.—Two miles above Fountain. Earnings made of $8 to $12.

Haskell Bar.—Eighteen miles above Fountain. Earnings at rate of $6 to $12 with rockers; $16 to $20 by sluicing.

Big Bar.—Rockers yielded $5 to $6.

Island Bar.—Reported as giving good yield.

BARS ABOVE ALEXANDRIA.—In 1859 several of these became
noted.

British Bar or *Cornish Bar.*—Thirty miles above Alexandria. In
a ditch five miles long had been made here.

Ferguson Bar or *Rich Bar.*—Three miles above last. Sixty dol
day to the man made here for some time.

Long Bar.—Seven miles above Quesnel has been worked almos
tinuously from early years. Earnings still about \$3 a day.

Spanish Bar.—Thirteen miles above above Quesnel; some wor
carried on.

Cottonwood Cañon.—On a high flat here some fairly coarse gol
worked.

*Tributaries of Fraser River and Places in its Vicinity not in
under Subsequent Headings.*

Yale Creek.—Near Yale. A little coarse and rough gold ob
here in late years.

Coquihalla River.—More or less coarse gold has been found
nearly the whole course of this stream, particularly where it c
area of the Anderson River slaty rocks, but it has never been exten
worked. In 1864 diggings yielding \$5 a day found on lower part
Hope. Good prospects found on *Ladner's Creek* and on *Pierre Riv*
butaries, and in 1861-62 a good bar worked on the Coquihall
below the mouth of the last-named creek.

Anderson River.—Some coarse gold found at one time ten miles
mouth, but not enough to pay.

Main River Thompson.—Heavy gold found on this river up to *Nic*
where, it is believed, the first placer gold in paying quantity in B
Columbia was found. This region chiefly worked by the Indi
the country, who, I am assured, have obtained many thousand
in specially favourable years. River-bars worked here and there
up as Kamloops Lake.

Lillooet River.—Flowing into Harrison Lake. Along this stre
1859, gold to the value of \$2 to \$4 a day obtained with rocker
\$8 by sluicing. Similar earnings in 1867.

Portage between Seton and Anderson Lakes.—In 1880 Indians re
to be making small earnings here.

McGillivery Creek.—Enters Anderson Lake eighteen miles from
on west side. Coarse gold found in 1880. Value \$18·50 per
Gold to the amount of \$1032 obtained in workings near mouth o
in 1881, and further working abandoned.

Cayoosh Creek.—Diggings discovered in spring of 1886 by C

Gold worth $18 to $18·50 per ounce. In 1886 yielded 725 ounces. Yield in 1888 estimated at about $52,000. Remunerative work has been carried on here uninterruptedly since the discovery. The gold obtained is on the lower ten miles of the creek, below the outcrops of certain gold-bearing quartz-veins, from which the placer gold is supposed to be derived. (See p. 71 R.) This creek affords a remarkable instance of rich placer deposits which have remained long undiscovered in a country supposed to be well known. Mr. Phair, Mining Recorder, writes:—"It seems almost incredible that this creek, within an hour's walk of the town of Lillooet, should have been passed by for a quarter of a century by hundreds, aye, thousands of the best practical white miners and prospectors of the Pacific Coast, and now at this late date the prize falls into the hands of Chinese." (Report of Minister of Mines of B. C., 1886, p. 207. See also same report for 1887 and 1888, pp. 273 and 312.)

Bridge River.—Discovered in 1858, and soon prospected nearly to its sources and some mining done throughout. Coarse gold for ten miles up from mouth, further up generally scale gold. Some nuggets found on lower part of river of from one to two ounces in weight, and one said to have been worth $300. This stream at first worked by whites, afterwards chiefly by Chinese and Indians. In 1866 Chinese said to have obtained gold to value of $66,000 to twelve men, by wing-damming. A good deal of the mining has been done of late years on the South Fork, which is reached by a journey of three or four days from Lillooet, *via* Seton Lake and across the mountains. Gold worth $16·50 per ounce, coarse, nuggets worth $10 to $22 having been found.

Gun Creek.—A tributary of Bridge River, fifty miles by trail from Lillooet. Placers discovered in 1859 yielding $6 to $15 a day.

Cadwallader Creek.—A tributary of Bridge River. Good prospects found here in 1886.

Hat Creek.—Small quantities of gold have been found here.

Scotty's Creek.—A tributary of Bonaparte River. Prospects reported to be good, but boulders in the valley render mining difficult.

Chilcotin River.—Gold in some quantity said to have been found near the mouth of this stream.

Nechacco River.—Colours obtained near Fort Fraser, and also abundant near its junction with the Fraser River.

Chilacco River.—In certain banks near its mouth, eight or nine colours to the pan may be obtained. A small quantity of coarse gold found in a lateral creek by one of the men connected with the Canadian Pacific Railway survey in 1876.

Cariboo District.

WILLIAMS CREEK.—For description see page 34 R. Discovered
and has yielded more gold than any stream in British Columbi
examples of the yield in early years it may be stated that S
claim gave a maximum yield of 409 ounces or $6524 a day.
$100,000 in all taken from this claim of eighty by twenty-five fee
1862, Cunningham's claim produced gold to the value of nearly
a day for the season, while on several days as much as fifty-two p
weight of gold was taken out. The Adam's claim yielded to e
its three partners $40,000, clear. These claims were above 'the cañ
shallow ground. The deep ground below 'the cañon' was first bot
near the end of 1861 by the Barker Co. (whence Barkerville).
Diller Company was the next successful in this, and it is cr
stated that here, on one occasion, 200 pounds of gold worth $
was obtained in one day. In 1863, three claims below 'the c
yielded $300,000, and twenty claims were steadily producing fr
to 400 ounces a day. Four hundred miners were at work on Wi
Creek in this year,—'the Golden year.' The aggregate yield of Wi
Creek, for the first seven years of working, for which no retur
available, was very large. In 1888 about twelve hydraulic
were being worked.

The tributaries of Williams Creek, in order down stream, are
lows:—

Mink Gulch.—Joins from the west. Hydraulic work at outl
paid well.

Walker's Gulch.—Joins from the west at Richfield Court
Deep work. Good prospects at different times and some quan
gold taken out at its mouth, but has not held out. Hydraulic
still in progress.

Grub, or *Black Jack Gulch.*—Joins from the west. A mere rav
no great length, being all embraced in one claim. Has afforded
pay by hydraulic method, but now worked out.

Stout's Gulch.—Joins from the west, below 'the cañon.' Very ri
now worked out for drifting. Hydraulic method employed.

Conklin Gulch.—Joins from the east, opposite Barkerville, disc
1874, and has since proved very rich; the Ericson claim in tha
yielding 400 to 500 ounces a day. Ground very deep for so
valley, being ninety feet in lower part and twenty feet in hi
drifting claim, one mile and a-half up; probably rich for hy
working.

McArthur's Creek.—Two miles below Barkerville and one mile
Lane and Kurtz shaft-house; joins from the south-west. Paid

drifting deep ground, but now worked out for this method. No hydraulic work in progress.

Creeks entering Willow River.—

Lowhee Creek.—Discovered, 1861. Runs northward, nearly parallel to Williams Creek, and empties into Jack-of-Clubs Lake, which also receives Jack-of-Clubs Creek, and is the source of the Willow River. Good pay found in both shallow and deep diggings, and some good ground still being worked. Gold, especially near source of creek, very coarse and rough, often including fragments of quartz. Found difficult to obtain water for hydraulic work here, but otherwise promising. The Jordon and Abbott claim in 1861, yielded from eighty to a hundred ounces daily, and in 1884, the Sage-Miller claim yielded for a time from 300 to 400 ounces a day.

Jack-of-Clubs Creek.—All deep work on this creek, gravel being 150 feet in depth near the mouth, where a few claims paid well. This creek is a favourite among those which are considered yet unproven, the impression being that an old channel exists which has not been found.

Musquito Creek and *Red Gulch.*—Entering Willow River from the south below the last have been very rich. The ground was fifty feet deep at mouth; now worked out for drifting. Hydraulic work has paid well.

Whip-saw Creek.—Three miles below Mosquito Creek, on the same side. In former years, from $10 to $12 per day per hand taken out, and more or less work carried on for many years by ground-sluicing and drifting. No work now in progress but considered promising.

Several creeks below Whip-saw Creek on the south-west side of Willow River, have afforded no pay; fair prospects have been obtained in some creeks on the north-east side, but no rich paying ground found.

Hardscrable Creek.—Joins Willow River from the north. Drifting and hydraulic work has been carried on, but without very important result.

Slough Creek.—Joins Willow Creek from south and east, seven miles below Jack-of-Clubs Lake. Chiefly bench and shallow diggings. Main valley never bottomed, but considered promising.

Burns' Creek.—Tributary of the last, from the north. Has yielded a good deal of gold from both deep and shallow diggings.

Devil's Cañon.—Joins Slough Creek from the south, half a mile below last. Bench mining still going on.

Coulter Creek.—Tributary of Slough Creek. Gold worked some years ago.

Nelson Creek.—Joins Slough Creek from the south-west four miles below Jack-of-Clubs Lake. Hydraulic work.

New Creek.—Tributary of Slough Creek. A little work done here a few years ago.

Dragon Creek.—Tributary of Willow River. Two miles of the part of this creek worked four years ago.

Rouchon Creek (sometimes called *Russian Creek*).—Joins W River from south, thirteen miles below Jack-of-Clubs Lake. Sh yielded $4 to $5 a day to the man. Mining still going on.

Barry or *Berry Creek.*—Joins Willow River from south-west miles below lake. Shallow diggings.

Archer Creek.—A little work on shallow diggings some years a

Deadwood Creek.—Joins Willow River from the west five mil low last. Shallow diggings.

Sugar Creek.—A branch of Valley Creek, which joins Willow from the east a short distance above Deadwood Creek. Some prospects, but never much pay. Some hydraulic work has carried on.

Cañon Creek.—A stream running into Willow River far dov course, and reached by a trail twenty miles long from Beave House. Prospecting has been carried on here, but no rich p found.

Creeks lower down Willow River are known to hold some gol have not yielded it in paying quantity.

Lightning Creek.—Discovered in 1861, and in that year $20 worth of gold taken from Campbell's Discovery claim and the adj Whitehall claim. Attempts were made almost from the first to the deep channel of this creek, but after much work, those were doned in 1864. Sinking was, however, resumed in 1870, and h proved successful, led to the subsequent great developments. rich character of some of the ground on this creek may be illus by stating that at one time the Butcher claim yielded 350 ou day, the Aurora, 300 to 600 ounces, and the Caledonia, 300 o For description see page 34 R.

The tributaries of Lightning Creek, in order, down stream, a follows:—

Amador Creek.—No good pay yet found.

Van Winkle Creek.—Discovered, 1861. About 2000 feet of the end of this valley paid well. In 1861 a company of four took o average amount each of $600 worth of gold during the season.

Dead Man's Creek.—

Perkins' Creek.—Some gold obtained here of late years.

Chisholm Creek.—Good pay in shallow workings. Deep groun proved, though great efforts have been made to test it.

Last Chance Creek.—Estimated that $250,000 worth of gold take

of this creek in a length of half a mile. Rich ground now probably worked out.

Davis Creek.—Good pay in shallow ground.

Anderson Creek.—Good pay in shallow ground.

Jaw-bone Creek.—No good pay found.

Peter's Creek.—Joins Lightning Creek from the south-east, a mile below Beaver Pass. Reported to have afforded a considerable quantity of gold. Not recently worked.

Basford Creek..—Tributary of the last. Work has been carried on here.

Campbell's Creek.—Also a tributary of Peter's Creek. Gold found and worked, but no particulars.

French Creek and *Canadian Creek.*—Joining Pleasant Valley from the south, have both yielded some gold and were found locally rich, though paying ground ran was through where the working was carried on. Probably not exhausted.

Grouse Creek.—Six miles east of Barkerville, heading with Antler Creek. Discovered 1860. Mined to some extent in 1861 and 1862, but with renewd vigour in 1864. The deep ground was very rich, and extended for about a mile near the upper part of the creek, giving out farther down. Deep ground worked out. Appearances favorable for hydraulic work.

Antler Creek.—Discovered 1859, but no work done till 1860. Heads in Bald Mountain, opposite Williams Creek, and was one of the first creeks worked in this part of the country. Shallow ground for two miles, paid well, and has been worked out. The deep ground has not yet been much tested, owing to the absence of clay, and consequent large quantity of water met with in sinking. All the gulches joining Antler Creek from the source down, have paid (*Wolf*, *California*, *Stephens'*, and *Begg's Gulches.*) The creek has never been bottomed where these side valleys fall in. Chinese have been at work, and get pay on benches 100 feet above the stream, a long way down. Antler Creek yielded gold to the amount of \$10,000 a day for some time in 1861. It is stated that one company of three men obtained in three weeks washing, \$83,300, and that in some spots the ground yielded \$1000 to the square foot.

Nugget Gulch.—Tributary of Antler Creek. Good pay found at mouth. Upper part not tested.

Victoria Creek.—Tributary of Antler Creek. Has been mined near the mouth.

Branch of Eight-mile Creek.—(Five miles north of Barkerville.) A little mining work carried on here in early years.

Pleasant Valley.—A transverse depression, four miles in le uniting the valleys of Williams and Antler creeks, and joinin former about three miles below Barkerville. Has never been bott or much prospected, but might be embraced in a scheme for dra the valley of Williams Creek. (See p. 37 R.)

Bear River, and country about Bear Lake.—Gold has not been here in paying quanity.

Swamp River—Has attracted some attention, but no good pa yet been found.

Cunningham Creek.—Discovered 1860, but not much worked till In early days, a crevice containing 600 ounces of gold was foun this creek, about twelve miles from its mouth. Several hyd claims have been worked here. Since 1864, attempts to reach the ground have been made, but have not succeeded. It has always supposed that the deep ground in this creek would turn out rich if once proven to be so, a large amount of work would immediat undertaken.

Harvey Creek.—The first gold in paying quantity in the Ca district proper was found here in 1860, but comparatively little was done till 1864. One claim—the Minnehaha—has been exceed rich. Another at the junction of Swamp River, has paid well. Cummings Company bottomed it at one place, and drifted up small cañon (unsuccessfully,) but found pay on entering wide gr The upper part of the creek is deep, and has not yet been thoro proven.

Creeks flowing into Cariboo Lake.—In *Nigger*, *Pine*, and *Goose C* small quantities of gold have been found. On the last-named, money was spent in putting in a flume, but with small result.

Keithly Creek.—Discovered in autumn of 1860. The main cree only moderately deep ground, (twenty to twenty-three feet,) of w some is yet unworked; it being expensive to open on account o great quantity of water. Benches 100 feet above the stream have for open work, and some of them for drifting also, while a numb Chinese, who worked about the mouth, also got good pay. A hydraulic work has been attempted here with fair results.

Main Snow-shoe Creek.—Tributary of Keithly Creek. Has mined about one mile up, affording good pay. Ground deep. A t about three-quarters of a mile long is being driven to work the bed-

Little Snow-shoe Creek.—Tributary of Main Snow-shoe Creek. is considered to be one of the most promising creeks of which the ground (though not extensive) has not been worked. Good

obtained from shallow workings. Hydraulic work has been steadily carried on for some years and pays well.

French Snow-shoe Creek.—Tributary of Snow-shoe Creek. Worked at one place, near the cañon, where the ground was shallow. Elsewhere, the deep ground has not been tested.

Four-mile Creek.—Tributary of Keithly Creek. Hydraulic mines and drifting near the mouth. Good pay.

Duck Creek.—Chinese have worked here. No recent mining of importance.

Spanish Creek.—Falls into North Fork of Quesnel River from the south (draining Spanish Lake) six miles below Cariboo Lake. Mining carried on at different times, but not recently. Prospects still considered favourable.

Black Bear Creek.—North Fork of Quesnel. Much prospecting and mining have been done here and coarse gold found, but no rich pay. Not yet considered faily tested, the ground being hard to work.

Kangaroo Creek.—Joins North Fork of Quesnel about two miles above its junction with the South Fork. Paid well at one time.

Cedar Creek.—Discovered in 1862, but scarcely worked till 1866. One pretty rich claim was worked here,—the Aurora—which yielded $20,000 in 1866. There were some other good claims in this year and the next. Pay-dirt six to eight feet thick. The creek is now worked by Chinese, who use the hydraulic method on a pretty large scale.

Coquette Creek.—Near the last. Discovered 1866, but soon given over to Chinese and worked by them for some years. Not worked in 1886.

Hazeltine's Creek.—Some encouraging 'prospects' have been obtained here.

Moorhead Creek.—Some work done here, but without good result. Prospecting still going on. (1886)

Quesnel River.—Discovered 1859. Most of the work done on bars of river, though many workings on benches one hundred to one hundred and fifty feet above the water pay well. The gold is all fine. This region is now altogether in the hands of Chinese who resort chiefly to the Forks and South Branch. Several hundred Chinese work in this district during the summer, and winter at the Forks. The North Branch is said to have afforded profitable diggings as far up as Cariboo Lake.

Swift River.—Rather inaccessible, and hard to work, being a rapid stream with many heavy boulders. Considerable quantities of gold have been taken from it from time to time, and Chinese still at work.

Fountain Creek.—A tributary of Swift River, nine miles west of Mount Agnes. Chinese mining.

Cañon Creek.—A second stream of the same name, joins the
from the east above Quesnel. Diggings first reported in 1865.
siderable quantity of gold obtained here formerly, some of i
coarse and mixed with quartz.

Hixon Creek.—Discovered, 1866. A branch of the last. A
worth $700 was found here, and considerable placer-mining carr
for a length of two miles and a-half on the creek.

Terry Creek.—A tributary of Cañon Creek. Discovered, 1867.
low diggings yielded $6 to $8 a day.

Goat River.—Discovered, 1886. East of the lower part of
River and flowing into Upper Fraser River. A trail cut out to the
in 1887, and some mining carried on.

Smoky River.—Discovered 1887. A tributary of Upper Fraser
from the north, some distance below last. Prospects of $3
obtained with rocker, and considered encouraging.

Horse-fly River.—South of Quesnel Lake. Discovered and pros
in 1859 and 1860, in which years some paying work done on Ho
Creek, the branch connecting Horse-fly Lake with the main rive
party of five here took out at one time 101 ounces of gold in a
Renewed excitement in 1867. More or less mining has since
carried out on this river and tributaries, particularly by Chinese.
no really important developments have occurred.

McLennan Creek.—Thirteen miles from Tête Jaune Câche, ru
into Cranberry Lake. Gold found in 1876, reported at $4 to $5
but owing to heavy boulders in the stream and expense of sup
has not been worked.

Similkameen, Rock Creek and Okanagan.

Main River Similkameen.—(Below Vermilion Forks.) Gold
in sharp unwashed particles at mouth in 1853, by Captain McLe
party. In the cañon, near the 49th parallel, a considerable qu
of gold obtained in 1859-60; the largest piece worth $22·50.
Whites remained on the river after the first few years, but much
was done by Chinese. In 1866, a little excitement occurred, and
or fifty Chinese went in to work. After this the river was
abandoned for some years, but about 1882, mining revived, and
Chinese have been at work, scattered along the river from Ver
Forks to the 49th parallel, ever since. Work confined to rive
and low flats bordering the river. Gold all scaly or fine.

Creek, six miles above Boundary.—(South side of river.) Chines
lately been working here.

Ashtinoulou River.—Joining Similkameen from the south. Scale gold found but Indians object to its being worked.

Siwash Creek, or *Five-mile Creek*.—Below Vermilion Forks on north side. Prospects obtained, but nothing to justify extensive work.

Wolf Creek.—Joins Similkamean about nine miles below Vermilion Forks on south side. This heads with the source of a small stream which joins the South Fork of Similkameen, about nine miles above Vermilion Forks, a low valley running through. Miners think that this valley represents an old channel of the river, and attempts have been made to bottom it, but without success.

South Fork Similkameen.—Gold discovered by government prospecting party under Mr. Allison in 1860, and Whites and Chinese have been working off and on ever since. $10 to $20 a day to the hand obtained occasionally in early years on bars. Gold fairly coarse for thirty miles up from mouth and also found above this point, but not worked. Chinese have worked also in a little creek about sixteen miles up on west side. (See Report 1877-88, p. 156, B.)*

Whip-saw Creek.—Tributary to South Similkameen, from the west. Worked in a desultory manner since discovery of gold on the river, the workings extending three or four miles up. Gold rather coarse. The bed-rock here and in the neighboring part of the Similkameen consists of Tertiary strata. It seems not improbable that richer deposits may be found beneath these in the pre-Miocene valley which they fill.

Skagit River.—'Prospects' found in several places in early years, but no mining north of 49th parallel. On *Ruby Creek*, a tributary further south, gold discovered and working began in 1879.

Nine-mile Creek.—A tributary of the last, heading near Granite Creek. Worked last summer for a mile or two from mouth. Gold rather coarse. More or less platinum found in this and on the streams previously mentioned.

Tulameen or *North Fork of Similkameen*.†—Some work done on this river as early as 1862, and though nearly all the white miners were drawn away to Cariboo about that time, it is nearly certain that Chinese have been working off and on ever since. Working resumed by whites as well as Chinese about nine years ago. River proved rich from mouth up for about two miles, and paying work still in progress at various places all the way up to two miles above Eagle Creek—twenty-three miles from mouth. Gold often coarse, and on lower two miles does not appear so much washed as further up. On this part of river, three years ago, one company aver-

* See foot-note p. 115 B.

† Localities in this vicinity are referred to in greater detail, as no published description of them has yet appeared in the Reports of the Survey.

aged earnings of $8 to the hand. Four years ago, several made as high as $20. All the work on the lower part river has been river-bar mining. Platinum is found everywher the river with the gold, and native copper in scales and nuggets ing as much as an ounce is occasionally found. Above Slate low benches and flats are mined by sluicing as well as the bed river by wing-damming, and Indians work here and there with It is thought that the extensive benches in the angle betwe Tulameen and South Similkameen would pay for hydraulic work is difficult to obtain water for this. Pellets of silver-glance, through with gold, have been found in sluice-boxes above Otter

Granite Creek.—Joins Tulameen from the south, nine miles a mouth. Gold discovered in 1885 and caused considerable excit resulting in a great rush to the creek in the same year. Ben terraces 200 to 300 feet high occur at mouth of creek, but thes been cut through as the drainage-level lowered, leaving a flat d fan, on which the town is built. Just above this the valley becom row or V-shaped and runs back between bold mountains which ris 2000 feet above it. At the bottom of the valley is a cañon 200 feet deep which continues for nearly four miles. Above this the part of the creek and its branches are wider and with lower and have not been bottomed. Nearly all the gold has been ol below the First Fork or in the first three miles and a-half in le the creek, in which the bed-rock was found at a depth of a fe There is very little bench- or side-ground along this part of the though an old higher channel, with good pay, is occasionally running across points (as at the Gladstone claim). One or mo of heavy gold are found in the 'fan' at the mouth of the creek, has yielded in places two ounces to a set of timbers, 10 x 5 feet. bed-rock has, however, not been reached below the mouth of the The greater part of the rich ground on this creek has been work being quite limited. The gold is coarse and rough, and the pla which sometimes amounts to half by weight, has the same cha denoting a very local origin. About half a mile above the First a patch of silicified Tertiary argillite occurs in the bottom of the shewing that the gorge is of pre-Miocene age, and the greater par erosion to which the concentration of the gold is due probab dates from this early period. Forty Whites, and about the same of Chinese on the creek in 1888. Several nuggets worth from $100 have been found. The yield of the creek is estimated at in 1885; $170,000 in 1886, and $90,000 in 1887.

Collin's Gulch.—South side of Tulameen opposite Otter River. gold found and a little work done. A small ravine only.

Cedar Creek.—South side of Tulameen above the last. Gold rather heavy. A little work done. One claim gave $10 a day to the hand the first season. Coarse platinum found with the gold.

Slate Creek.—South side of Tulameen four miles above Otter River. Gold discovered 1885. Work in progress since 1886. Best result in 1887, $7 a day to the hand. Small hydraulic claim working at mouth. Gold coarse and associated with coarse platinum.

Bear Creek.—North side of Tulameen one mile above last. Creek runs on bed-rock at mouth, and here a nugget worth $320 was found. Above the mouth ground deep and has not been bottomed. Much gold on the Tulameen below mouth of this creek, which appears to deserve further work.

Hine's Creek.—A small gulch above the last, on the opposite side of the river. 'Prospect' of coarse gold.

Eagle Creek.—Joins Tulameen from north-west two miles and a-half above Bear Creek. Coarse gold found but not much mining done.

Champion Creek.—Joins Tulameen from south-east, about six miles above last. A large stream affording good prospects, but the ground has never been bottomed.

Boulder Creek.—Joins Otter River from the west, near its mouth. Apart from Granite Creek and the main river, most of the work in 1888 done here. Worked for about a mile and a-half up from mouth.

Rock Creek.—East of Osoyoos Lake; a tributary of Kettle River. Gold discovered in 1859 or 1860. The narrow valley of the creek paid well for about a mile up, yielding generally one to two ounces a day to the man. Some of the benches also paid, in one case, yielding half an ounce a day to the hand for a season's work. In 1861, 300 miners were at work here, but it was nearly abandoned in the following year. Working was renewed to a considerable extent in 1866. In 1868, $8 to $10 a day to the hand was obtained by ground-sluicing, and a bed-rock flume was constructed. In 1870 the Flume Company took out $6000 at their first 'clean up.' At the mouth of the creek, a large quantity of gravel had been deposited where the valley widened, and this was all thoroughly worked over, chiefly by Chinese, who have never quite abandoned these diggings. Desultory work among large boulders, which obstruct the channel, was carried on for many miles up the creek in early years, and lately a good deal of successful placer work has been done about ten miles up the creek. It is near the last-mentioned place that the 'quartz' discoveries elsewhere mentioned (p. 68 B) have taken place.

Boundary Creek.—Joins Kettle River from the north-east. Developed

a little later than the last. Some very coarse gold found here, good deal of desultory work done, but pay 'spotted.' Like th the valley of this stream is narrow and cañon-like, and most mining was done near its mouth, and in places further up, wh widened locally.

Kettle or *Nehoialpitkwa River.*—'Prospects' found and small qua of gold obtained on this river and several of its tributaries, nea the head, but no mining of importance ever carried on. Countr thickly wooded and difficult of access.

Okanagan River and Lake.—Scattered diggings found in 1859-6 most of these soon abandoned; some because of want of wat working, and others probably left at the time of Cariboo excit In 1851, Mr. Cox, Gold Commissioner at Rock Creek, writes:- prospected nine streams, all tributaries of the lake, and found g each, averaging from thirty to ninety cents a pan."

Mission Creek.—Joining Okanagan Lake from the east, is th one of the streams above mentioned on which mining of impo has occurred. Mining began on this creek about 1875 or 1876 a continued more or less actively since, attempts being made hydraulic machinery. Paid at one time at rate of two to three to two to three dollars a day to the hand. Gold worth $18 ounce. The greater part of the gold was obtained at a place seven miles up the creek, where it issues from a narrow, rocky into a wider valley. The stream-bed gave the best returns, but b and flats have also been worked. The modern gravels here r soft Tertiary shales, and are more or less cemented by calc matter in their auriferous layers. It is quite possible that a channel remains to be found here beneath the edge of the Te Gold coarse. (See Report 1877-78, p. 157 B, also p. 48 R of this re

Cherry Creek.—Tributary of Shuswap River, thirty-five miles e head of Okanagan Lake. Gold mining has been prosecuted her varying success for thirteen years or more. The richest groun been found in the lower three miles and a-half of the south b Bed of creek here originally worked by wing-damming, and con able work on benches and flats. In 1877 the best claim was p about $10 a day to the hand. Nuggets worth $40, $90 and $130 been found, and the gold generally is coarse. Assay value $15 $16 per ounce, the alloy of silver being rather high. (See R 1877-78, p. 158 B. Also p. 68 R of this Report.)

East and West Kootanie. (South of line of C. P. Railway.)

Wild Horse Creek.—Discovered to be auriferous in 1863, and be an important camp, with four hundred miners, early in the foll

year. Ordinary claims were then paying from $20 to $30 a day to the hand. In 1865, estimated that one thousand men were here and forty to fifty claims were working, producing one to three ounces to the hand. Nuggets valued at $100 have frequently been obtained. The portion of the valley rich in gold is about two miles only in length. The bed-rock was found at no great depth below the present stream-bed in this part of the valley. The lower part of the old channel deepens rapidly and has never been reached. Profitable work has never ceased on this creek since its discovery, though the yield has fallen off after the first years. The value of gold obtained from 1878 to 1887 (ten years) is returned at $231,380. The greater part of the gold is now obtained by the hydraulic method, five companies being at work in 1888. Yield in 1888, $24,400, though only a portion of the flumes and sluices were 'cleaned up' before winter. The gold is worth $18·25 an ounce. (Report 1885, p. 152 B.)

Bull River.—Ten miles southward from Wild Horse Creek, coarse gold has been obtained from time to time in paying quantity near the cañon, but can be worked only at low water.

Findlay Creek.—Thirty-two miles northward from Wild Horse Creek. Diggings discovered in 1865, and more or less mining from time to time. Much trouble from freshets, but prospects considered excellent. In 1886, an English company obtained a grant of about four miles on upper part of the creek where gravel benches prospect well. A ditch five miles long has been constructed, and hydraulic work begun. A second hydraulic company is at work further down on the creek.

Dutch Creek.—Lower end Upper Columbia Lake. Gold has been worked here to a limited extent from time to time.

Toby Creek.—Lower end of Lower Columbia Lake. Diggings found in 1864, and considerable excitement for a time. Renewed interest in in 1885, when twenty men went to work on it, but in 1887, no work was in progress.

Cañon Creek.—Five miles south of Golden Station, C. P. Ry. Discovered 1883. Some coarse gold obtained and a few miners reported to be making $8 a day in 1884. In 1887, no work. Work to be resumed by a company in 1889.

Quartz Creek. Falling into Columbia River near Beaver Station, C. P. Ry. Gold discovered in 1884, but not at that time in paying quantity. About eighteen miles from Donald. Nineteen locations taken up in 1888, and active work expected. Ground ten to fifteen feet deep.

Porcupine Creek.—A tributary of Quartz Creek. Eighteen miles from Donald Station, C. P. Ry. Five claims worked in 1888, averaged $16 to the hand a day.

Perry Creek.—A branch of St. Mary River. Coarse gold fou
1867. In the following years claims reported as generally yield
ounce a day. In 1869, a large number of miners on the creek.
ing carried on since with little interruption, but generally in a des
manner. Below the falls a "clay bed-rock" was met with, be
which was a deeper layer of auriferous gravel. This was reach
some places, but the water generally prevented work. Reporte
in 1869, gold to the value of $1500, was obtained in the deep g
from eight square feet of ground. The Perry Creek Gold Minin
are now at work here on a somewhat extensive scale, and wit
prospect of success. They have a tunnel over 550 feet long at the p
time, running for bed of old creek, three miles above the site
old mining camp. Their shaft, five miles above the same pl
temporarily abandoned, owing to water.

Moyie River.—Placer camp located here in 1869. Mining has
carried on ever since with varied results, but never very extens
Diggings said to be 'spotted.' Earnings of $3 to $4 a day
man have been obtained. Gold worth over $18 per ounce, and
coarse. Only three Chinese at work in 1888.

Pend d'Oreille River.—Somewhat extensive work in early
yielding from $3 to $4 a day.

Weaver Creek.—Flows into Moyie Lake. Very coarse gold f
High assay value. More or less work has been irregularly carri
for many years. In 1888 about $5000 in coarse gold obtained.

Palmer's Bar Creek.—Empties into Moyie River about four
above lake. More or less work for a number of years, but no str
developments. Coarse gold. Yielded $1023 to a company of four C
men in 1888.

Boulder Creek.—Flows into Kootanie River about twenty-five
from Bonner's Ferry. Coarse gold found.

Nigger Creek.—Situated between Weaver Creek and Palmer's
Some work for a number of years. Coarse gold but 'spo
Abandoned in 1887.

Kootanie River.—Chinese have obtained fair wages near To
Plains and below, but no regular work.

Gold Creek.—Flows into Kootanie River near Tobacco Plains,
to the Boundary line. Fine gold, not found in paying quantity.

Deer Creek.—Flows into Upper Arrow Lake about the middle,
the west. Prospect of heavy gold at time of Big Bend exciteme

Fish River.—Enters north-east arm of Upper Arrow Lake. K
to be auriferous.

Mosquito Creek.—A western tributary of the Columbia, be
Upper and Lower Arrow Lakes. Gold found.

Lardo River— Entering Kootanie Lake at north end, from the west. Gold found.

Slocan River.— Joining Kootanie River from the north below the lake. Gold found.

Howser Creek.—On this and another stream tributary to Duncan River, which flows into the north end of upper Kootanie Lake, coarse gold has been found. No work of importance.

Salmon Creek.—Flows into Pend d'Oreille River, near its mouth. Work here in 1865 and later, and some good results.

Forty-nine Creek.—Flows into Kootanie River below the lake. Work in 1867 and later. In 1867, reported to yield coarse gold to the value of $6 to $18 to the hand. This creek and the last, head toward the Toad Mountain area, where quartz developments, elsewhere described, are in progress. Bed-rock not worked.

Cottonwood Creek.—Joins lower end of west arm of Kootanie Lake. Prospects obtained.

Columbia River.— Wherever suitably circumstanced bars occur along this stream, to the north of the 49th parallel, fine gold is found in greater or less quantity. In 1865, several hundred Chinese were at work within a short distance above Fort Shepherd. On bars five miles above Revelstoke, $1·50 to $2·50 a day is obtained at low water.

Big Bend Country.

French Creek.—Tributary of Gold Creek nine miles from its mouth. Fifty miles north of Revelstoke, C. P. Ry. Discovered 1865, and in that year yielded at least $32,000. In 1866 the Big Bend excitement occurred, and this creek is reported to have produced gold to the value of $100,000. In this year or the next, four, six and even twelve ounces to the hand a day was obtained on some claims, and one nugget worth $253 was found. French Creek was the richest in the Big Bend region. Lower part of valley all deep ground which has never been bottomed. The creek was entirely abandoned for a number of years, but work was resumed in 1886, attention being chiefly turned to the unexplored deep ground, with promising indications. Creek and hill claims, however, still being worked with some success. Mr. G. M. Sproat estimates that this creek and its tributaries affords about twenty-five miles of mining ground. A company at work in 1888 did very well toward the autumn, when they lost the pay streak. (See Reports of Minister of Mines of B.C., 1886, 1887, 1888.)

McCulloch Creek.—A tributary of Gold Creek, four miles lower down than the last. Reported as a short creek, about four miles only in length. History like that of French Creek, and as in the case of

that creek said to have yielded about $100,000 in 1866. Yielded $1 a day to the hand in some claims in early years, and nuggets a rough gold with quartz attached found on it. Surface diggings wo ed out and deep ground found very difficult and full of boulde Work resumed in 1886, and has been continued to date, compan driving tunnels for deep ground with good prospects. A bed-ro flume company obtained a considerable amount of coarse gold in 18 on the lower part of the creek. (See Reports of Minister of Mines B.C., 1886, 1887, 1888.)

Downie Creek.—Flows into Columbia River from the east, thir five mile above Revelstoke. A large stream, but appears never to ha been systematically prospected. Moderately good pay said to ha been found at one place eight or ten miles up it in 1867.

Carne's Creek.—East side of Columbia River, twenty miles north Revelstoke. Discovered 1865. This creek is six miles long to forks, and each of the branches is supposed to be about the sa length. A cañon quarter of a mile from the mouth; wide gra banks below cañon; valley narrow above it. Mining on bars in ea years, the old valley not having been followed owing to water. Coa gold. For a time, below the cañon, earnings were $15 a day. Wo renewed in 1886 in several places, one company making $8 to $10 day to the man on the average. Bed-rock conjectured to be from fo to seventy feet deep. Work difficult on account of floods. Creek co sidered promising mining ground, and the benches suited for hydrau work. (See Reports of Minister of Mines, B.C., 1886 and 1887.)

Smith's Creek.—A large stream joining the Columbia from the w opposite Gold Creek. In 1886 fifteen white miners here making to $11·20 a day to the man. The creek is twenty-five miles long a is considered promising. Fair 'wages' made here in 1888. A co pany putting in a long flume. (See Report of Minister of Mines B.C. 1887.)

Fernie Creek.—Joins Columbia River eight miles above last. Coa gold. In early years, $8 a day to the hand made by four men fo whole season. Mr. Sproat remarks that there are, including this a Smith's Creek, nine large creeks on the west side, and three on the e side of the Columbia, between Gold Creek and the mouth of Ca River, in which pay gold was found in 1887, all worthy of being ca fully prospected.

Frenchman's Creek.—The second stream up Canoe River on the e Gave good pay found for a season, some years ago.

North Fork Illecillewaet River.—Gold has been found here, but li worked.

Kamloops Region and North and South Thompson Rivers.

Nicola River.—Scale gold found for about twenty miles up the Nicola, or as far as the mouth of Spioos Creek, also on Spioos Creek and its north-west branch, Prospect Creek. Only a little desultory mining done.

Nicola River, above Douglas Lake.—Some gold found in 1887, and worked to a limited extent by Whites and Indians.

Guichon Creek.—Prospect of fine gold reported in stream flowing in from the east below Mamit Lake.

Deadman River.—Joins Thompson River from the north below Kamloops Lake. A Chinese company worked on the east branch, in the cañon a short distance above the forks, for one season. Ground probably poor.

Tranquille River.—Enters Kamloops Lake from the north. Gold discovered 1858, and appears to have been worked with little interruption ever since, chiefly by Chinese. For many years twenty to thirty Chinese have been continuously employed here, but latterly the number has decreased and the earnings are now supposed to be small. The gravels worked are those of the banks and bed of the stream, and flats adjacent to it. Gold has been found for a distance of eight miles, in all, up the stream. It is mostly scaly and some platinum is associated with it. The rocks cut through by the stream are Tertiary volcanic materials, and the origin of the gold is obscure. (See Report of 1877-78, p. 155 B.)

Cherry Bluff Creek, Kamloops Lake.—Gold has been found here, and a little work was attempted at one time.

North Thompson River.—A few of the river-bars, not far above Kamloops, at one time paid to work.

Jamieson Creek.—Thirteen miles up North Thompson, west side. Some mining has been carried on here.

Louis Creek.—Twenty-nine miles up North Thompson, east side. Some mining said to have been done here as early as 1861, when $8 to $10 a day was reported to be made. Chinese and others have occasionally worked here since, chiefly in and just below the cañon, near the mouth of the creek. Higher tributaries to the south-eastward considered promising.

Barrière River.—Thirty-two miles up North Thompson, east side. Mining said to have been carried on here with good results in or about 1861.

Adams River and Lake.—Some mining was carried on here in early years, and gold reported lately on some small streams flowing into the lake, but nothing of importance developed.

Shuswap River.—More or less fine gold said to occur on bars along whole course. Some work done in early years.

Scotch Creek.—Flows into lower part of Great Shuswap Lak
mining done here at different times previous to 1877 but a
for a number of years. Mining renewed in 1885 and in 188
the value of $22,000 produced. In the following year, the yi
$4000, and the creek is now again abandoned except by a few
Mining was carried on as far up as the forks, eight miles fro
of creek. Gold coarse, sells at $17 an ounce.

Omenica Region and Peace River.

Vital Creek.—Tributary of Omenica River. Gold found 18
work done one mile and a-quarter from mouth in ground fro
four feet deep. One-tenth of metal found 'silver' (arqu
which some nuggets were three ounces in weight. Some wor
progress in 1886.

Silver Creek.—Tributary of the last. 'Two-and-a-half-dol
gings found in 1870.

Omenica River.—More or less gold on the bars.

Germansen Creek.—Discovered in 1870 and soon became the
mining locality. Flows into Omenica River on south side,
in lake near head-waters of Vital Creek. In 1870 good sha
gings for three miles, yielding half an ounce to three ounces
day to the man. Total yield in this year $70,000. In 1871 m
going on. Three men, near the mouth, took out ten ounces
the man, but there were many blanks. Some hydraulic
benches has been successfully carried on. 'Silver' (arquerite)
in this creek. Some work still in progress in 1886.

Mansen Creek.—Flows into Mansen Lake. Gold discover
Yielded $20 a day to the man in some places, and nuggets
and $100 were found. Two companies sank shafts to deep
with good results in this year. Only two companies at work
and making little. Some work still going on in 1886.

Slate Creek.—A tributary of the last. Found rich in 1872,
off greatly in the following year. Miners stated to be ma
penses in 1875.

Lost Creek.—A tributary of Mansen Creek. The "Irwin Com
five men took out 192 ounces in a week in 1871. Another
sank fifty to seventy feet to the deep channel and got large pay
the deep channel never bottomed. Little work in 1875. So
going on in 1885.

Skeleton Creek.—A tributary of Mansen Creek.

Elmore Gulch.—Some gold obtained. Mining profitable in

Black Jack Gulch.—A tributary of Mansen Creek. Five
1871 made $200 a day continuously here.

Mansen River.—(Below the lake). Diggings reported in 1871 but appear to have been soon abandoned.

Kildare Gulch.—Yielded a little gold in 1881 and 1882.

May Creek.—(Osalinka of maps). A tributary of Omenica River. Yielded a little gold in 1882.

Finlay River.—This large river is well thought of by all the miners who have seen it, but has not been thoroughly prospected, and none of its tributaries above Omenica River have been examined. Fine gold on all the bars, and in 1861, on a bar three miles up from its mouth, three and four ounces a day to the hand obtained.

Nation River.—A tributary of the Parsnip from the west. Streams near head-waters known to be auriferous but very little prospected.

Parsnip River.—The lower portion of this river proved highly remunerative for a limited time. Bar mining and fine gold. Its eastern tributaries appear to be well worth prospecting.

Iroquois Creek.—Between Forts St. James and McLeod. Gold reported. (Report, 1875-76, p. 257.)

Peace River.—Formed by the confluence of the Parsnip and Finlay. To the east of the Rocky Mountains, gold was found by a couple of prospectors from Quesnel in 1861. Scale and flour gold along the whole course. Many of the bars at first yielded $10 to $15 a day to the hand.

Cassiar District.

(Facts relating to gold mining in Cassiar district are given in somewhat greater detail, and in connexion with its geological features, in Annual Report, 1887, Part B.)

Stikine River.—Gold discovered 1861. Very fine gold all along river, but little profitable work below Clearwater. The good ground extended thence to Grand Cañon, above Telegraph Creek. Coarse gold was found in a few places above Telegraph Creek, in the cañon. Bars on Stikine at first averaged $3 to $10 a day to the man, and as much as two to three ounces sometimes obtained. Work has now practically ceased, possible earnings being reduced to $1 to $4. The circumstances appear to indicate the existence of an old channel above the present river-bed and beneath the basalts, in the cañon. Below Telegraph Creek, extensive benches at various levels which should pay for hydraulic work. (See p. 47 B.)

Tahl-tan, or *First North Fork of Stikine.* Heavy gold found and worked for a number of miles up this stream. Pellets of 'silver' (arquerite) also found.

Tooya, or *Second North Fork of Stikine.*—'Prospects' obtained, but no serious work known to have occurred.

Dease Creek.—Joins Dease Lake from the west. Discovered 1873. Formerly yielded from $8 to $50 a day to the hand, from the mouth for about six miles up. Further up, some isolated good claims worked. The bed of the creek is nearly worked out, the ground having been shallow. A few bench claims still yielding fairly. Hydraulic work on a small scale. Gold coarse and generally well rounded; worth $15 50 to $16 per ounce.

Thibert Creek.—Joins Dease Lake from the west, near lower end. Discovered 1873. Good ground for about six miles up from mouth. Yield at about same rate as last. Creek bed worked out, but benches and side-ground being worked by hydraulic method and drifting. Gold coarse, worth $16 an ounce.

Mosquito Creek.—A tributary of the last. Very good 'prospects' have been obtained here; as much as $40 to a six-foot set of timbers.

Defot Creek.—A tributary of Cañon Creek, which is on the same (west) side of the Dease, with the last. Gold coarse, rough and often full of quartz. Large nuggets, including one of fourteen ounces. Has been, for a limited area, (about a mile in length) one of the richest pieces of ground in the district. The gold is evidently derived from massive deposits of quartz, which occur at the head of the creek, at a considerable elevation.

Beady Creek.—Dease River, east side. A little bar-mining in 1874 and 1875, but nothing of importance developed.

Eagle River.—Dease River, east side. Good prospects, but no mining carried on.

McDame Creek.—Enters Dease River from the north. Discovered 1874. Highest earnings from $6 to $100 a day, when mining at its best. Gold coarse, worth $17·75 to $18 an ounce. Comparatively little work done in the stream-bed, the best ground being an old high-level channel, worked in places for fifteen miles up. Bench claims run for about seven miles up. Valley wide, with numerous tributaries, most of which yield gold. Gold has also been found on heads of streams flowing to the north, beyond the McDame water-shed.

Snow Creek.—A tributary of the last. Discovered 1875. The richest single claim in Cassiar was near the mouth of this creek, and paid for a week 300 ounces for six or eight men. Seventy-two ounces washed from one pan of dirt in 1876. Now nearly worked out. Gold worth $18 an ounce. Decomposed rusty quartz containing gold, found on this creek.

Quartz Creek.—A branch of Trout Creek, tributary of McDame Creek. Discovered 1875. Highest average $5 to $20 a day. Gold coarse and rough, with quartz attached. Nearly worked out.

Rosella Creek.—Tributary of McDame Creek. Discovered 1876,

Highest average per day \$5 to \$15. Gold worth \$18·25 an ounce. Abandoned.

Patterson Creek.—Discovered 1877. Highest average per day \$5 to \$20, generally paid 'wages' at \$6. Gold worth \$18 an ounce. Abandoned.

Dennis Creek.—Discovered 1877. Returns about same with last. Gold worth \$18·25 an ounce. Abandoned.

Gold Creek.—Discovered 1877. Best earnings per day \$5 to \$50. Gold worth \$18 an ounce. Bench and creek diggings. Abandoned.

Slate Creek.—Discovered 1877. Highest average earnings \$10 a day. Gold worth \$18 an ounce. Bar diggings. Abandoned.

Somer's Creek, or *First North Fork of McDame.* Discovered 1876. Earnings of \$10 to \$100 a day made. Gold worth \$18 an ounce. Abandoned.

Third North Fork of McDame.—Discovered 1877. Creek and hill diggings. Abandoned.

Spring Creek.—Discovered 1877. Earnings of \$10 to \$20 a day were made. Gold worth \$18·25 an ounce. Principally hill diggings. Abandoned.

Fall Creek.—Discovered 1877. Some gold obtained. Abandoned.

Rapid River.—Dease River, below McDame Creek. Prospects obtained, but no mining of importance.

French Creek.—Dease River, north side, below McDame Creek. Some gold obtained.

Walker Creek.—Discovered 1876. Said to be distant about seventy-five miles in an easterly direction from mouth of McDame Creek. Probably a tributary of Black River. Some gold obtained, but results have never been satisfactory.

Black, Turnagain or *Muddy River.*—Reached by same trail as last, and said to be about ninety miles distant from McDame. Fine gold obtained on bars, and supposed that coarse gold may occur near head-waters, but has not yet been discovered.

Lower Liard River.—(Below confluence of Dease).—Here Messrs. Thibert and McCullough first discovered gold, and for some years a good deal of work was carried on upon river-bars, the gold being fine. The best known bars, in order down the river, were—*Porcupine Bar*, about fifty miles below the mouth of the Dease, north side of river; *Bed-rock Bar*, about five miles below last, on south side of river; *McCulloch's Bar*, near site of Old Fort Halkett.

Upper Liard River.—(Above confluence with Dease). 'Prospects' and more or less river-bar mining in a number of places. In gravel-beds resting on old rocks at the Lower Cañon, 'wages' at \$4 a day can be obtained with rocker.

The following creeks in Cassiar District, which are reported as having yielded some gold, I am unable to place:—*Mitchell's Creek, Brown's Gulch, Poorman's Gulch* or *Creek, Fred Hart Creek.*

Yukon District.

This district is beyond the northern boundary of the province of British Columbia, which is constituted by the 60th parallel. A summary of the few facts relating to its placer deposits is, however, included here. The two localities first referred to below, are naturally attached to the Cassiar district, and have been prospected from that district.

Sayyea Creek.—Joins Upper Liard from the west, about fifty-five miles above the Frances. Good prospects were obtained here in 1875, of coarse gold. Little work has been done, but reported that the paying ground gave out.

Finlayson River.—Joins Frances Lake from the west. Prospecting done at mouth, ten or twelve years ago, gave earnings at $8 to $10 a day. Many streams in this region have a very favourable aspect, and have never been prospected. (Report 1887, p. 113 B.)

Lewes River.—Gold discovered, 1880. Mining began, 1881. Remunerative river-bars occur all along this river below the mouth of the Tes-lin-too or Newberry, but the richest so far worked are within a distance of seventy miles below this point. Many bars yield $10 a day to the hand. Cassiar Bar, which has proved the best, is said to have yielded $30 a day to the hand in some cases, but is now worked out. Gold all fine. The whole length of this and other rivers will, doubtless, eventually be worked when the county becomes more accessible. (Report 1887, p. 180 B.)

Tes-lin-too River.—A tributary of the last. Bars similar to those of the Lewes as far up as Tes-lin Lake. (See Report 1887, p. 156 B.)

Ni-Sutlin-hi-ni.—The main feeder of Tes-lin Lake. Similar river-bars. A little work has been done on them. (Report, 1887, p. 156 B.)

Big Salmon River.—A tributary of the Lewes. River-bars, with more or less fine gold, along whole course, but no good paying bars yet worked. (Report, 1887, p. 152 B).

Upper Pelly River.—Remunerative river-bars discovered in 1882, and some of these, between the mouth of the Lewes and the Macmillan, have been worked. More or less gold on bars as far up as they have been prospected. (Report, 1887. p. 134 B.)

Ross River.—A tributary of the last. This stream is believed to be the one on which several miners made at the rate of $18 a day some years ago. (Report, 1887, p. 134 B.)

Stewart River.—Tributary of Pelly or Yukon, from the east. Gold discovered, 1885, and in this year and 1886 as much as $100 a day to

the hand made on river-bars. Probably $100,000 worth of gold already obtained. Gold all fine, but reported to become somewhat coarser far up the stream. Very little black sand found with the gold, but garnet sand common. More or less platinum associated with the gold here and on all the streams in the Yukon basin.

Sixty-mile Creek.—Between Forty-mile Creek and Stewart River, west side of Pelly or Yukon River. Pieces of quartz containing gold found in drift. Prospects of alluvial gold found, but no placer work carried on.

Forty-mile Creek.—Tributary of Pelly or Yukon, from the west. Discovered, autumn of 1886. Coarse gold and nuggets found here, the only place, so far, in the Yukon district. Earnings as high as $100 a day to the man occasionally. A number of miners making $14 a day in 1887, but in 1888 earnings small, owing to continued high water. The stream is said by the miners to be a 'bed-rock creek,' *i. e.* one without deep drifting or sinking ground.

Region of the Coast Ranges and Skeena River.

Seymour Creek.—Burrard Inlet. Some gold got here at one time, but work abandoned.

Prospect Creek.—East Branch Homathco River, above Tatlayoco Lake. Some fine gold found here by men connected with C. P. Ry. survey in 1875.

Homathco River.—Prospects obtained, but no mining done so far as known.

Lorne Creek.—Skeena River; discovered 1883. Valley reported deep and narrow. Gold obtained principally in bed of creek, though sideground and benches favorably spoken of. Much trouble has been experienced from floods. Yield reported in 1884, $17,000; 1885, $18,000; 1886, $12,000; 1887, $3,795.

Bone's Gulch.—Skeena River. Producing a little gold in 1886 and 1887.

Douglas Creek.—Kitsumgalum, Skeena River. Prospecting in 1886 and a little gold got, but work abandoned.

Other streams flowing from Cascade Range.—Prospects have been obtained in a number of these, but details are wanting and no important placer-mining has been developed.

Vancouver Island

Leech River.—This stream has proved auriferous for four or five miles of its length, where it flows along the strike of a belt of slaty argillites. It was discovered in 1864, and within a few years thereafter

yielded gold to the value of $100,000 to $200,000, according to various estimates. Gold often coarse and nuggety, and earnings as high as $34 a day to the rocker were reported in 1864. The rich ground found in the present river-bed is supposed to be exhausted, though desultory mining has been carried on ever since at intervals. A good deal of 'crevicing' has been done on bed-rock. Benches rather extensive and all contain more or less fine gold. The "Gordon Hydraulic Mining Company (Limited)" have lately acquired an extensive tract about half-way between Sooke River and the North Fork of Leech River, and are putting in hydraulic machinery. For details on Leech River see Report, 1876-77, p. 95.

Sooke River.—(Below its junction with Leech River).—Fine gold only found here and probably derived from Leech River.

Goldstream Brook.—Runs on strike of Leech River slates, further east. 'Colours,' but no pay, found here.

Jordan River.—Discovered and worked about the same time with Leech River. Coarse gold obtained, largely by 'crevicing.' It has been estimated that $30,000 worth of gold was taken out within a few months after discovery.

Nanaimo River.—Attracted some notice in 1877, but has never proved rich. A few Whites and Chinese work here almost every year, making small wages. They follow the river up to its head, which is not far from that of China Creek, Alberni Canal.

San Juan River.—Entering San Juan Bay at about twenty miles above salt-water. Some coarse gold obtained by 'crevicing' on a short length of this stream. Formation reported to be slate.

Cowichan River.—Mr. Brown, of the Vancouver Island Exploring Expedition, (1864) reports gold on all the bars of Cowichan River in quantities of one quarter of a cent to three cents to the pan.

Foley's Creek.—(Cowichan Lake?) Mr. Brown reports: "'Prospects' to $2 per day and one which ought, to an experienced miner, to pay from $5 to $8 per diem."

China or *Atlat Creek.*—Situated about seven miles down Alberni Canal from its head, on south side; not named on chart. Discovered about 1871 and worked steadily for three years, chiefly by Chinese. A little work still going on. Paid for a distance estimated at twenty miles up from mouth and gold found to sources. Earnings of Chinese supposed to have been about $5 a day. Some prospecting for 'quartz,' with hopeful results, has been done in mountains about this creek.

Awatsish Creek.—At 'First Narrows,' lower down inlet than last, but rising in the same mountains with it. Some coarse gold has been found, but ground very bouldery, and no serious work has been attempted.

Bear River.—Head of Clayoquot Sound. An excitement about this place got up in 1862 and 1863, and again in 1887, when twenty to thirty Whites and many Chinese visited it. Fine gold found but not in paying quantity. Mr. Buttle, of Vancouver Island Exploring Expedition, reported occurrence of coarse gold on one of the sources of this river.

Gold River.—Nootka Sound. Prospected on several occasions. Fine gold found, but not in paying quantity.

Cape Commerell.—North end of Vancouver Island. Beaches with black sand containing gold. Little has yet been done to ascertain whether the gold is in remunerative quantity.

Cape Cook.—Two smaller streams on outer end of this cape, and one on south side, give 'prospects,' but bars quite limited and never worked.

Ou-ou-kinsh Inlet.—A small stream here known to yield a fair 'prospect.'

Streams tributary to Puntledge Lake and a little stream just east of Cape Commerell are also known to contain gold in small quantity.

For some of the above notes relating to Vancouver Island, I am indebted to Mr. J. Jacques.

Queen Charlotte Islands.

No paying gold-placers have ever been found in these islands, though gold is present in fine scales in deposits of magnetic iron sand, which are met with about Cape Fife, and possibly elsewhere. (Report 1878-79, p. 33 B.)

GOLD (AURIFEROUS VEINS).

The principal known occurrences of gold-bearing veins, as distinguished from placer deposits, are enumerated in the table of assays of the precious metals, pp. 76 B *to* 79 B. *In Mr. Bowman's report on the Mining District of Cariboo about* 100 *localities of quartz-veins in that district, known or reputed to be auriferous are catalogued and described, and these it is not considered necessary here to repeat. A few localities only which are not included in the table of assays, or in Mr. Bowman's report, are mentioned in the subjoined short supplementary list.*

Mitchell or *Gold Harbour, Queen Charlotte Islands*.—Rich gold-bearing vein, referred to on p. 17 B, exact position marked on Admiralty Chart No. 2168, and in Geological Map of Queen Charlotte Islands, published in Report for 1878-79. Mr. Woodcock, who again prospected this place in 1878, informed me that the original vein was probably

not over three feet thick, and appeared to be worked completely in an excavation thirty feet long by twelve feet deep. The vein quite vertical. Green crystalline country-rock, probably diabase. Woodcock found some small quartz seams about a mile and a-half fr the original locality which contained visible gold.

Sebastopol Creek.—About sixty miles up the Skeena River above Kitsalas. "Sebastopol ledge," situated about two miles up stream. Assay by Mr. Tiernan, of Victoria, reported as giving—g $42·18, silver, 13·47 to the ton.

Clinton.—Loose specimens of hæmatite and quartz containing visi gold, found here in 1886, but not traced to their origin. Reported yield gold to the value of $300 to the ton on assay. (Report Minister of Mines of B. C., 1886, p. 207.)

Near Cottonwood Creek.—(Near Toad Mountain, West Kootan A number of claims located on free-milling gold-ores; reported to rich, and high assays are quoted by Mr. Sproat. (Report of Ministe Mines of B. C., 1888, p. 299).

Near Lardo River.—(West Kootanie.) Free-milling gold-qua reported to contain $4 to the ton, has been found. (Report of Minis of Mines of B. C., 1888, p. 304).

Findlay Creek.—(East Kootanie.) Free-milling gold-quartz report (Report of Minister of Mines of B. C., 1888, p. 307).

Big Bend Region.—In addition to the places mentioned in the ta of assays, it may be stated that rich specimens of gold-bearing qua derived from the "Homestead" and "Big Bend" claims, have b received.

Vicinity of Rock Creek.—Free milling gold-ores reported here, addition to silver-ores. Rich hand specimens received. Referred p. 68 R.

Monashee Mine.—Between Cherry Creek and Kettle River. F gold reported. Referred to p. 68 R.

The following claims covering veins known or reported to cont gold, generally in association with some silver, are in the vicinity of Lower Fraser, "Teague's" Harrison Lake; "Seymour Creek," "Lott "No Surrender" and "Vancouver," at various places on or n Burrard Inlet. I am unable to furnish any authentic particul respecting these.

Texada Island.—Gold-ores recently discovered here, and many clai recorded. No particulars yet available. See p. 74 R.

SILVER.

The principal known localities of silver-ores have already been enumerated, either on pp. 56 B to 74 B, or in the Table of Assays, pp. 76 B to 79 B. See also some references under Copper, p. 101 B. It would serve no useful purpose to endeavour to name the many hundred individual claims which have lately been recorded on silver-ores, even if it were possible to do so. This supplementary list contains known occurrences of silver amalgam (arquerite) or native silver, so far found only in connexion with gold-washings.

Vital Creek, Omenica District.—Considerable quantities of arquerite, often in nuggets, found here in the placer-mines. A specimen subjected to analysis contained 83·30 per cent. of silver. See p 73 B.

Similkameen River.—(Near Vermilion Forks.) Small quantities of native silver or arquerite found in gold-washings, occasionally weighing two to three pennyweights. (Report 1877-78, p. 162 B.)

Mission Creek, Okanagan Lake.—Pellets of native silver or arquerite found occasionally with the gold. (Report 1877-78, p. 162 B.)

Similkameen River, near the Boundary-line.—Small pieces of native silver or arquerite occasionally found in gold-washings.

Nicoamen, Thompson River.—Native silver occasionally found in gold washings. Small pieces of this material have been obtained and prove to be silver and not arquerite. In 1858 and 1859 pieces of considerable size are reported to have been discovered.

Tahl-tan River, Cassiar District.—Arquerite found in gold-washings. (Report 1887, p. 80 B.)

COAL AND LIGNITE.

In the following list of localities of coal and lignite, no attempt is made to enumerate the very numerous occurrences and outcrops in the well known coal-fields of Nanaimo and Comox, nor even to mention individually the various workings upon these, which have already been described, and for information upon which the foregoing pages, as well as the various Reports of the Survey, must be consulted. In the less known regions, I have endeavoured to mention all the scattered discoveries which have come under my notice.

Queen Charlotte Islands.

Cowgitz, Skidegate Inlet.—Anthracite coal referred to on page 85 B. (See also Report, 1878-79, p. 71, B, 1872-73, p. 56.)

South Side of Skidegate Inlet.—Anthracite coal, much disturbed small out-crop. (Report 1878-79, p. 68 B.)

Ya-koun River.—Bituminous coal of good quality and reported to be 18 feet thick, referred to on p 86 B. (See also Report 1887, p. 17 T.)

Chin-oo-kun-dl Brook.—Lignite. Impure and thin seams. (Report 1878-79, p. 85 B.)

Ya-kan Point.—Lignite. Irregular deposits on the beach. (Report 1878-79, p. 86 B.)

Skon-un Point.—Lignite. Beds of some thickness on the beach. (Report 1878-79, p. 86 B.)

Ma-min River, Masset Inlet.—Lignite in thin seams six miles up this river. (Report 1878-79, p. 88 B.)

Naden Harbour.— Stream on east side. Drift lignite in the brook. (Report 1878-79, p. 89 B.)

Vancouver Island.

Nanaimo District.—Bituminous coal which has been worked for many years. Described on p. 90 B. (See also Reports 1876-77, p. 170, 1871-72, p. 81, 1873-74 p. 96, 1874-75 p. 82.)

Comox District.—Bituminous coal, now being opened up on an extensive scale. Described on p. 89 B. (See also Reports 1876-77 p. 161, 1871-72 p. 76, 1872-73 p. 32, 1873-74 p. 95.)

Campbell River.—This stream flows into Discovery Passage. Bituminous coal reported on it about twelve miles inland. (Report 1886 p. 19 B.)

Kuhushan Point.—Coal reported in stream which reaches the coast, half a mile south of this point. (Report 1886, p. 18 B.) This locality and the last are included in the northern continuation of the Comox coal-field.

Forward Inlet area, Quatsino Sound.—Bituminous coal. Thin seams only found as yet, noted on p. 86 B. (See also Report 1886, p. 83 B.)

Koprino area, Quatsino Sound,—Requires exploration by boring. No coal outcrops known. Referred to on p. 87 B. (See also Report 1886, p. 86 B.)

Koskeemo area, Quatsino Sound.—Bituminous coals, noted on p. 86 B. (See also Report 1886, p. 89 B.)

Suquash.—Coal. Noted on previous pages (p. 80 B, 88 B.) (See also Report 1886, p. 62 B., *et seq.*)

Kluksiwi River.—Coal seam near here of sixteen inches in thickness. (Report 1886, p. 62 B, *et seq.*)

Ki-uk River and vicinity.—Bituminous coal in thin seams. (Report 1886, p. 62 B. *et seq.*) This locality, and that preceding it are included in the Suquash coal-field.

Saanich Inlet.—Thin coal-seams found in several places in this vicinity, but none, so far, of value. Included by Mr. Richardson in Cowichen area. (Report 1876-77, p. 187.)

Sooke.—At the entrance of the harbour, and elsewhere in that vicinity, lumps of coal or lignite found upon beaches. Probably derived from Tertiary rocks of which an area there occurs. A boring was at one time made to a depth of 139 feet, but did not pass through any coal. (Report 1874-75, p. 83, 1876-77, p. 190.)

Head of Alberni Canal.—Coal is reported here and rocks of the Cretaceous coal-bearing series occur, but have not been fully examined.

Clayoquot Sound and *Ucluelet.*—Bituminous coal found in several places in this vicinity, but no geological examinations yet made.

Cowichen Bay.—Small fragments of anthracitic coal have been found in sandstone here by Mr. Richardson.

Koquesila River.—Specimens of impure anthracite obtained some distance up this stream. A little prospecting work has been done here.

Mainland of British Columbia.

Sandstone River.—North-east side Malaspina Strait. Coal or lignite, in thin irregular layers. There is a considerable area of sandstones etc. here, probably of Cretaceous age, but a small thickness only is exposed in the river. (Report 1886, p. 31 B.)

Vicinity of Vancouver.—Burrard Inlet. Two series of lignites or lignite-coals come to the surface here. The upper series is seen near the Brewery, Brewery Creek, half a mile south of False Creek and elsewhere, both east and west of that point. The lower series is seen near Ostranders Point, Stanley Park, and again on the line of strike, to the eastward, within half a mile to a mile west of Hastings. All the seams so far found are quite thin, seldom exceeding a few inches.

Kanaka Creek.—Near Haney Station, C. P. Ry. At about four miles above the mouth of this stream, seams a few inches thick, of coal or lignite-coal occur.

Warnock Creek.—Near Warnock Station, C. P. Ry. Two-thirds of a mile up from mouth of creek, small seams of coal or lignite.

Stave River.—Half a mile above mouth of river, a small seam of coal or lignite.

Mission Hills.—About five miles up Stave River. Some fragments of coal or lignite reported, but have not been traced to source.

Slalets Mountain.—Near Sumass Mountain. At this place, about five miles south of Frank Wade's store and landing, a seam over twenty inches in thickness of excellent coal has been found

Chilliwack River.—Irregular 'bunches' of good bituminous coal found in sandstones about three miles and a-half south-west of Chilliwack village (Centreville) near the road from that place to Capt. John's village, and about half a mile north-east of the road-crossing of

the river. Many other occurrences of similar coal are known
Cultus Lake range of hills, which skirts the Sumass valley
analysis No. 19, p. 98 R).

(The above notes on places near the Lower Fraser are supple
A. Bowman, and are given at greater length, as they are not el
available in published form.)

Junction of Nicola and Coldwater Rivers.—Coal, noted on pa
(Report 1877–78, p. 125 B.)

Coldwater River.—Coal, of same formation with last, in
places. (Report 1877–78, p. 126 B.)

Quilchena.—On McDonald's River, which enters Nicola I
this place, at about three miles and a-half from the lake. Li
poor quality. Thickest seam exposed about two feet.

Guichon Creek.—Joining Nicola River from the north. Li
good quality found three to four miles up this stream, but bed
exposed.

South Fork of Similkameen River.—(Above the mouth of the
ten) Lignite reported in micaceous sandstone. (Report 1877–78,

South Fork of Similkameen River.—(Four miles above Ve
Fork) Lignite. (Report 1877–78, p. 130 B.)

South Fork of Similkameen River.—(Quarter of a mile abo
milion Fork, south bank.) Lignite or lignite-coal of good
which has been worked lately to a small extent for local use.
opened, shews an upper seam nine feet thick, with a few sma
partings, below this, some feet of mixed lignite and shale, and
seam of clean lignite-coal four feet or more in thickness, the
being below water-level.

Tulameen River.—(Three miles above Vermilion Fork) Ligni
feet thick with one shaly parting of three inches. (Report 1
p. 132 B.)

Rock Creek.—(Half a mile from mouth on Kettle River.)
thickness not known.

Kamloops.—(Three miles south-west of town.) Good coal
of Tertiary rocks, but so far thin seams only found. See
(Summary Report, 1888, p. 5.)

Crow Nest Pass.—Rocky Mountains. Bituminous coal, near
Creek. See pp. 93 R, 97 R. (Report 1886, p. 69 B., 1887, p. 1
North Kootanie Pass.—Rocky Mountains. Coal in thin se
western slope of "West Summit." The coal actually observed
not of workable thickness, but the measures are the same wit
of Marten Creek, and it is highly probable that important co
may be found here. This is the nearest part of the "Elk Riv
taceous Trough" to the Kootanie valley, from which it is only

miles distant by the valley of the Wigwam River. (Report 1885, p. 64 B.)

Fording River.— A tributary of Elk River, Rocky Mountains. Coal in several thin seams, the thickest seen in small natural exposures being two feet. (Report 1885, p. 109 B.)

Green Hills.— Elk River valley, Rocky Mountains. Near the summit of these hills, about four miles south of the last locality, a coal seam several feet in thickness, poorly exposed.

The above three localities, with that of Marten Creek, are all situated on the Elk River Cretaceous Trough, on the western water-shed of the Rocky Mountains. There can be little doubt that there is here an important coal-field. Other Cretaceous areas in the Rocky Mountains being to the east of the water-shed are not included in the province of British Columbia. (See Report 1885, with accompanying map.)

Kootanie Valley near Bull River.—Lignite. So far found only in loose pieces. (Report 1885, p. 151 B.)

North Thompson River.— (Forty-five miles above Kamloops.) Bituminous coal of good quality in thin seams. (Report 1877–78, p. 113 B.)

Fraser River.—(East side, a short distance above the cantilever bridge.) Lignite. Thin seams.

Nicoamen, Thompson River.— Lignite. Seams so far found thin and impure.

Hat Creek, near Marble Cañon.— Lignite forty feet thick. (Report 1877-78, p. 140 B.)

Fraser River.— Between Soda Creek and Fort George, and at Quesnel. Lignite seams frequently exposed. That at Quesnel of poor quality. See p. 97 B. (Report 1875-76, p. 257.)

Lower Nechacco River.— (East of Fraser Lake.) Extensive Tertiary formation, but drift-lignite only known. (Report 1876-77, p. 82.)

Upper Nechacco River.— (South of Fraser Lake.) Lignites seen in several places about eight miles south of the lake. Thickest bed four feet. (Report 1876-77, p. 82.)

Blackwater River.— Drift lignites at Upper and Lower Cañons and along intervening portion of river. (Report 1875–76, p. 256.)

Chilacco River.— Drift lignite only found.

Nazco River.— Drift lignite found near Cinderella Mountain. (Report 1875–76, p. 254.)

Ko-has-gan-ko Stream.— South-west of Tanyabunkut Lake. Lignite of good quality, four feet or more in thickness. (Report 1876–77, p. 76; 1877-78, p. 48 G.)

Boyd's, or *Cold Spring Home.*—Lightning Creek, Cariboo. Lignite bed, 6 to 10 feet thick, and of fair quality.

Bear River.—(Near crossing of old C. P. Ry. surveyed line, lat. 54°). Coal reported and said to be about eighteen inches thick.

Parsnip River.—Lignite in place, and abundant in loose pieces. (Report 1875-76, p. 71.)

Kitsequecla, Skeena River.—Impure coal observed in Cretaceous rocks. (Report 1879-80, p. 103 B.)

Babine Portage, near Babine Lake.—Impure coal, observed. (Report 1879-80, p. 104 B.)

Upper Skeena.—Two localities, 9 and 20 miles respectively above Skeena Forks. Impure coals, like the two preceding. (Report 1879-80, p. 105 B.)

Watsonkwa River.—(Eighteen miles above Skeena Forks.) Bituminous coal, reported to occur in quantity. Noted on p. 93 B. (Report 1879-80, p. 105 B.)

Pine River Cañon.—(Five miles above Lower Forks). Peace River district. Bituminous coal in four thin seams, the thickest being 2 feet. (Report 1875-76, p. 53.)

Coal Brook.—East Branch of Pine River. Peace River district. Coal in several thin seams. (Report 1879-80, p. 117 B.)

Cañon of the Mountain of Rocks.—Peace River. Bituminous coal in thin seams, of which the thickest observed is 2 feet. (Report 1879-80, p. 119 B.)

Tahl-tan River.—Cassiar district. Lignite reported to occur in Tertiary rocks.

Rapid River, Cassiar.—Lignite-coal about two feet thick reported near mouth.

Dease River.—(Eight miles above mouth.) Cassiar district. Lignite in thin beds. (Report 1887, page 95 B.)

Liard and *Frances Rivers.*—(Below and above their confluence.) Yukon district. Lignite. Thickest observed bed 3 feet. (Report 1887, p. 111 B.)

Chilkat Pass.—(Near the head of Chilkat River, 40 or 50 miles north-west of head of Chilkat Inlet.) Bituminous coal, which, in specimens examined, seems to be of good quality. Reported to occur in quantity in an area of sandstones, shales, etc., which runs in a north-westerly direction.

Lewes River.—(Lat. 62° 15′, long. 136° 25′.) Yukon district. Lignite coal. Several seams, but none observed of great thickness. (Report 1887, p. 148 B.)

Pelly, or *Yukon River.*—At Coal Creek, five miles below Forty-mile Creek, on east side of river. Two seams of coal or lignite-coal, reported by W. Ogilvie, of 5 and 7 feet in thickness respectively.

IRON.

South-west Shore, Texada Island.—Magnetite. Described on p. 99 B. (Report 1886, p. 36 B.)

North-east Shore, Texada Island.—Magnetite. Irregular masses in limestone, with a more or less stratiform aspect. Thickest mass seen, 4 feet. (Report 1886, p. 39 B.)

Island in the Walker Group.—Magnetite of exceptionally rich quality. This occurs on a small rocky inlet near the north end of the Walker Group, in Queen Charlotte Sound. The deposit has not been examined. (Report 1872-73, p. 82.)

Rivers Inlet.—About 25 miles up the inlet on the north side. Magnetite, resembling the Texada ore. Deposit said to be extensive.

Entrance of Rivers Inlet.—West side of Fitzhugh Sound. Magnetic iron ore reported. (Report 1873-74, p. 101.)

Harriet Harbour, Queen Charlotte Islands.—Magnetite. Noted on p. 101 B. (Report 1878-79, p. 54 B.)

North side Skincuttle Inlet, Queen Charlotte Islands.—Magnetite. (Report 1878-79, p. 53 B.)

Cape Commerell.—North end of Vancouver Island. Magnetic iron sands along the shores, but scarcely in sufficient quantity to be of economic importance. (Report 1886, p. 77 B.)

Knight Inlet.—One mile up river, at head of inlet, on left bank, 1200 feet up mountain. Magnetite reported. (Report 1873-74, p. 100.)

Opposite Seymour Narrows.—About six miles inland from Menzie's Bay. Iron ore. Reported to be a considerable deposit. (Report 1873-74, p. 101.)

Skidegate Inlet, Queen Charlotte Islands.—Clay ironstone in numerous and large nodules in several places in the coal-bearing rocks.

Baynes Sound Mine, Comox.—Clay ironstones in considerable quantity in association with the coal seams. Two specimens, examined by Mr. Hoffmann, gave 36·83 and 29·78 per cent. respectively of metallic iron.

Alberni Canal.—Magnetite. About a mile below China or Atlat Creek. Considerable veins traversing the rock on the shore

Sooke.—(East side of harbour). Magnetite. Noticed on page 100 B. (Report, 1886, p. 17 T.)

Sooke.—(near the last). Hæmatite. Seen in exposure on the beach, but deposit apparently not extensive.

Near Hope.—A good specimen of magnetite. Reported as occurring about ten miles from Hope.

Near Nicoamen.—Ravine at the mill, about half a mile below Nicoamen. Vein or irregular deposit of magnetite with iron pyrites. The latter in such large quantity as to render the ore valueless.

Loadstone Mountain.—Near old "Brigade Trail," from Tulameen River to Hope, nine miles south-west of mouth of Otter River. Magnetite in numerous veins, traversing an intrusive mass of diorite. Veins actually observed, near the summit of the mountain, about six inches in thickness.

Iron Mountain.—On Nicola, near mouth of Coldwater River. Specular iron-ore in numerous small veins. Veins several feet in width reported but not actually observed. (Report, 1877-78, p. 122 B.)

Similkameen Valley.—(Three miles above Keremeoos, north side.) Schistose hæmatite found. (Report, 1877-78 p. 86 B.)

Bull River Cañon.—Kootanie Valley. Massive hæmatite, occasionally coloured with copper carbonate. Found loose in considerable quantity. (Report, 1885, p. 151 B.)

Cherry Bluff, Kamloops Lake.—Magnetite, in numerous, irregular veins traversing a greenstone mass. Some veins observed as much as three feet in thickness. The ore is of excellent quality. Specimens were found to contain 66·83 per cent. of metallic iron, with very little sulphur or phosphorus. (Report, 1877-78 p. 118 B.)

Watkinson's, Fraser River.—(about 23 miles above Lytton.) Magnetite. Vein said to be twenty feet in thickness,

Quesnel. — Clay ironstone in Tertiary rocks, often converted into hæmatite by the natural combustion of adjacent lignite-bed. Similar clay ironstones occur in many places in the Tertiary rocks of the Province in greater or less quantity.

COPPER.

(*See also Table of Assays of ores of the Precious Metals, pp.* 76 B *to* 79 B.)

Near head of Salmon Arm, Jarvis Inlet.—Deposit of bornite and copper-pyrites. (See p. 102 B.)

Knight's Inlet.—Ore similar to the last, very rich in hand specimens, locality not examined.

Entrance to Howe Sound.—(Three miles north of Atkinson Point Lighthouse) Copper pyrites found in 1865, and a considerable amount of prospecting work done at one time, but now abandoned.

Texada Island.—(Malaspina Mine.) Copper- and iron-pyrites in gangue of calcite and quartz. Accessory minerals, andradite, tremolite, chlorite and molybdenite. See p. 102 B. (Report 1886, p. 34 B.)

Sansome Narrows.—Copper-pyrites. Some prospecting work done a number of years ago, but now abandoned. The ore appears to follow cleavage-planes in the rock.

South-west side Dean Canal.—Specimens of vein-stone with yellow and purple copper ores, collected by Mr. Horetzky.

Head of Kitimat Inlet.—Small deposit of copper-pyrites and galena observed by Mr. Richardson.

Homathco River.—Entering head of Bute Inlet. Many specimens of vein-stones containing copper-pyrites and some purple ore, have been brought from this river, not examined.

Gnarled Islands,—North of Dundas Island, Dixon Entrance. Copper pyrites, small veins only seen.

Ellerslie Channel.—Near Milbank Sound. On the west shore of Nikus Arm some work was done several years ago on a vein containing pyrrhotite or magnetic iron-pyrites and copper-pyrites. This deposit is known as the "Hebrew mine," and appears to deserve further examination as a copper-ore.

Port Simpson.—"Chimseyan Ledge". On the hill behind the village. Pyrrhotite with copper-pyrites in quartz gangue. A little prospecting work done.

Discovery Passage.—(Two miles and two-third south of Otter Point) Quartz vein with copper pyrites, not large. (Report 1886, p. 44 B.)

North side of Skinkuttle Inlet, Queen Charlotte Islands.—"Old copper mine," copper pyrites in small quantity with magnetite. See p. 102 B. (Report 1878-79, p. 53 B.)

Copper Islands, Skinkuttle Inlet.—Small irregular strings and bunches of copper pyrites in many places. (Report 1878-79, p. 52 B.)

Copper Bay.—(Between Cumshawa and Skidegate, Queen Charlotte Islands.) Copper-ores occur here and some prospecting work done at one time. (Report 1878-79, p. 29 B.)

Small Island off Port Frederick, Queen Charlotte Islands.—Copper-ore reported by Captain Stuart, H. B. Co.

Coast two miles east of entrance to Sooke Harbour.—Copper-ore discovered 1864. Shaft sunk 120 feet, now abandoned. Native copper and copper-pyrites. See p. 102 B. (Report 1886, p. 19 T.)

South Similkameen River.—(East bank, six miles above mouth of Whip-saw Creek.) "British Columbia Copper Co's. Claim." Deposit consisting chiefly of copper-pyrites, said to assay $20 to the ton in silver, appears to be rather irregular. Prospecting work done in 1882-83. The same belt of rock with that containing the copper is said to have been traced in a north-westerly direction to Whip-saw Creek, and to shew more or less copper throughout.

Near head of Wolf Creek.—(About twelve miles above Vermilion Forks, Similkimeen.) Large body of copper ore reported to have been discovered by Mr. Jamieson, in 1888. Said also to contain silver. (Report of Minister of Mines of B.C., 1888, p. 318.)

Tulameen and *Similkameen Rivers.*—Native copper in small grains, and occasionally in pellets weighing several pennyweights, found in gold washings.

Between Rock and Boundary Creeks.—Deposit of grey copper ore found in 1888. Reported to be extensive and several claims taken up on it.

Toad Mountain Region.—The silver-ores of this locality contain a large percentage of copper. See p. 102 B.

Jubilee Mountain, Columbia River.—Though referred to on a previous page as deposits of the precious metals, composed largely of copper sulphurets. See p. 102 B.

Stump Lake Region.—Many of the ores found here, though chiefly valuable for the precious metals, contain a high percentage of copper.

Brisco Range, Rocky Mountains.—(Opposite lower end of Upper Columbia Lake.) Rich copper-ore consisting of chalcocite, bornite and copper-pyrites. Holds no gold or silver. (Report 1885, p. 27 B.)

Copper Island, Shuswap Lake.—Beds of talcose or nacreous schists, about six feet thick, impregnated with a considerable quantity of copper-pyrites. (Report 1877-78, p. 98 B.)

Copper Creek, Kamloops Lake.—Irregular veins or impregnations of copper-ore in trap rocks. Native copper is also reported to have been obtained here by the Indians in former years. (Report 1877-78, p. 116 B.)

Cherry Bluff, Kamloops Lake.—Copper-ores with magnetite near the west end of the bluff. (Report 1877-78, p. 117 B.)

Watkinson's, Fraser River.—(About 25 miles above Lytton). Grey copper (tetrahedrite) in considerable mass.

Thompson River.—(Rock-slide about six miles above Spence's Bridge, east bank). Copper-ores in irregular deposits, associated with breccia, etc. Apparently unimportant.

Thompson River.—(Six miles below Spence's Bridge). Rich purple ore found loose.

Thompson River.—(Nine miles below Spence's Bridge). A rough fragment of native copper found here, weighing several ounces.

Fraser River, near Hope.—("Murphy's Mine.") Vein containing copper, rather wide and well defined. Said also to contain $15 to $45 in silver. A long tunnel run in 1859, and work resumed for a time in 1879.

Fraser River.—(About 30 miles above Fort George). Nugget of native copper weighing several pounds, found loose.

Fraser River.—(Ten miles below Lillooet). Small lumps of native copper found in gold-placers.

Bate's, or 150-mile house, Cariboo Waggon Road.—Nugget of native copper, weighing about 15 pounds, found near here.

Vital Creek, Omenica.—Pellets of native copper found in gold washings.

Quesnel River, near The Forks.—More than half a ton of native copper, in nuggets, obtained here during gold placer-mining. The precise locality appears to be "Twenty-mile Creek," which enters the river a little below Morehead Creek.

Boulder Gulch, Thibert Creek, Cassiar.—Mass of native copper weighing about 15 pounds, found here. Also found in small nuggets in gold workings on other streams in Cassiar district. (Report 1887, p. 82 B.)

NOTE.—As elsewhere stated, traces of copper ores and small irregular deposits in veins and jointage-planes, or disseminated through rock-masses, have been observed in a great number of places, which it is not considered necessary to enumerate here.

LEAD.

Most of the localities in which ores of lead are known to occur have already been noted in connexion with silver-ores. See pp. 56 R *to* 75 R. *Districts or localities likely to yield a considerable proportion of lead in connexion with silver-mining are, therefore, here merely mentioned. Reference should be made in this connexion to the Table of Assays of Ores of the Precious Metals, pp.* 76 R *to* 79 R.

Mount Stephen, or *Tunnel Mountain.*—Extensive deposits of galena, holding a large percentage of silver. (See p. 66 R.)

Illecillewaet Region.—Large deposits of galena, often rich in silver. (See p. 63 R.)

Hot Springs Camp, Kootanie Lake.—Large deposits of galena and 'carbonate ores,' often rich in silver. (See p. 61 R.)

Hendryx Camp, Kootanie Lake.—Extensive deposits of galena, containing a moderate amount of silver. (See p. 62 R.)

Rock Creek and Vicinity.—Galena ores, often containing a high percentage of silver. (See p. 68 R.)

Omenica Region.—Veins of galena abundant; generally rich in silver. (See p. 73 R.)

Nass River.—Specimens of galena ore given to the late Mr. J. Richardson by Mr. W. Lyons. Precise locality was not stated, and the specimens have not been tested for silver.

Lower Cañon, Upper Liard River.—Galena in irregular veins. Percentage of contained silver not known.

Chilcotin River.—Specimens of galena collected by Mr. Tiedemann. Percentage of contained silver not known.

Near Indian Village, Cumshewa, Queen Charlotte Islands.—Numerous small veins in agglomerate, holding a little galena and iron pyrites. (Report 1878-79, p. 77 B.)

Galena is also present in greater or less quantity in a number of the Cariboo mines, but does not appear to be so rich in silver as in the Selkirk region Of veins in Cariboo in which galena occurs in notable quantity, the "*Home Rule Ledge*" near Barkerville, and the "*Holmes Ledge*" on Break-neck Ridge, Snow-shoe Plateau may be mentioned.

ANTIMONY.

Near Watkinson's, Fraser River.—About two miles below the iron ore locality already mentioned, and say 23 miles above Lytton. Vein about 14 inches wide, containing much stibnite, with quartz and calcite. Contains also traces of gold, and 2·187 ounces of silver to the ton. (Report 1887, p. 58 T.)

Cumshewa, Queen Charlotte Islands.—Specimens containing antimony and arsenic, probably from this place, obtained by Captain Stuart, H. B. Co.

PLATINUM.

Upper Similkameen and *Tulameen Region.*—Platinum, often in nuggets, observed in a number of localities where gold-mining is carried on. (For the names of these places see p. 104 R.)

Tranquille River, Kamloops Lake.—Found in fine scales with gold. (Report 1877-78, p. 155 B.)

Fraser River.—Mentioned as occurring in very fine scales, with gold, particularly at a place ten miles below Lillooet.

Yukon River.—Found in small quantities, in fine scales, with river-bar gold on all, or nearly all, the tributaries of the Yukon which have been worked.

MERCURY.

Wapta (Kicking Horse) Valley, Rocky Mountains.—("Ebenezar Mine," three miles from Golden.) Bright red cinnabar disseminated in gangue of calcite. Deposit prospected to some extent, but not proved to be of economic importance. (Report 1886, pp. 41 D., 9 T.)

Homathco River.—Cinnabar found here during railway survey. Lode reported well defined and traceable for three-quarters of a mile. Country rock slate. The precise locality is, north side of Homathco River, nearly opposite station 3300, Cambie's Location Survey of 1875.

Fraser River.—Grains of cinnabar obtained in gold-washing near Boston Bar.

Fraser River, 12 miles above Kelly's Lake Creek.—Some way up a stream which flows in from the west, at this place, rich specimens of cinnabar containing native mercury, found.

Vicinity of New Westminster.—A rich specimen of cinnabar, reported by Mr. A. J. Hill, to have been found loose here.

Silver Peak, near Hope.—Globules of native mercury seen in some parts of the silver-ore found at this place.

Molybdenum.

Near head-waters of South Fork Spuzzum Creek, Fraser River.—Molybdenite in quartz veins. Fine specimens received.

Point east of Carrington Bay, Cortez Island, Strait of Georgia.—Molybdenite in small quantities in quartz veins.

Texada Island.—Molybdenite at Malaspina copper mine, in the vein.

Near head of Salmon Arm, Jarvis Inlet.—Molybdenite in association with copper-ore at the locality previously noted. (See p. 152 B.)

Knight Inlet.—Molybdenite reported.

Upper part of Cowichen River.—Specimens of molybdenite brought from here.

Lillooet River.—Specimen of molybdenite received from this vicinity per Mr. A. J. Hill.

Structural Materials.

Building Stones, etc.

(*Mention is here made merely of several localities in which stone has been quarried, and of some others which are so circumstanced as to appear to be of importance.*)

Nelson Island, Jarvis Inlet.—Pinkish-grey granite. Takes a good polish, and has been used in the construction of the dry-dock at Esquimault. Well situated for quarrying.

North Arm of Burrard Inlet.—Grey granite, easily quarried in blocks of any size, at the water's edge, and used in construction at Vancouver.

Admiralty or Salt Spring Island.—Greenish-grey sandstone of excellent quality. Easily quarried and shipped. Used in construction of dry-dock at Esquimault.

Pender Island.—Sandstone of good quality quarried to a limited extent. Known as "Browning Island stone."

Newcastle Island, Nanaimo.—Sandstones quarried here has been used in the construction of the mint in San Francisco, etc. (See p. 107 B.)

Near Nanaimo.—Sandstones from an extension of the measure
Newcastle Island. Quarry opened in 1875.

Chase River Quarry, near Nanaimo.—Sandstones similar to those a
noted.

Texada Island.—Grey, white and blotched marbles in unlin
quantity. These have been quarried to a small extent at Marble
on the north-east shore, three miles and a-half from the north poi
the island. Useful for ordinary purposes of construction, and taki
good polish. (Report 1886, p. 34 B.)

Beaver Cove, north-east coast of Vancouver Island.—Half a mile up
stream, which enters at head of cove. Grey marbles, often handso
variegated, have been quarried to a limited extent.

White Cliff Island.—(Between Chatham Sound and Grenville Chan
Marble, white, grey and pinkish. Attempt made to open a quar
1878.

Marbles occur in many other places at which no work has occu
on or near the coast of British Columbia. Among these may be
tioned :—

Nimpkish Lake.—Grey and mottled marbles in great abundance.

Near Horne Lake, between Qualicum and Alberni.—According to M
Richardson, a great variety of ornamental marbles suitable for al
all purposes. (Report 1873-74, p. 101.)

The following eight localities are those noted in the course
somewhat minute examination of the shores of the Strait of Geo
and Queen Charlotte Sound in 1885, as well adapted for the openi
quarries of building stone of good quality. None of them have
been utilized :—

Near entrance to Squirrel Cove, Cortez Island.—(West side of entra
Pale greyish hornblendic granite. (Report 1886, p. 23 B.)

Walsh Cove, Redonda Island.—Pinkish-grey granite. (Report 1
p. 24 B.)

Bay on south side of Hardy Island, near Jarvis Inlet.—(West en
island) Granite. (Report 1886, p. 31 B.)

Otter Cove, Discovery Passage.—Pinkish granite. (Report 188
45 B.)

Small Island opposite Chatham Point, to the north.—Granite like
last. (Report 1886, p. 47 B.)

West shore of Port Harvey, Johnston Strait.—Grey granite, als
several other places in this vicinity. (Report 1886, p. 50 B.)

Haddington Island, Broughton Strait.—Grey calcareous sandstone.
extensive quarry might be opened here with facility. (Report 188
57 B.)

Ledge Point, Port McNeill.—Near the last locality. Sandstone,

harder and less favourably circumstanced for working than the last. (Report 1886, p. 61 B.)

Of localities of building-stone in the interior of the Province it is possible only to mention a few in the immediate vicinity of the line of Railway:—

Near Cantilever Bridge, Fraser River.—Excellent grey granite quarried here, for use in construction of piers.

North Bend, Fraser River.—Similar granite quarried here, to a limited extent. This and the foregoing place may be taken as representing a large number of localities which might be utilized along this part of the Fraser.

South Side of Kamloops Lake.—Nearly opposite Tranquille, cliffs of tufaceous sandstone and brown dolerite occur which might afford building-stone of fair quality.

South Thompson River.—(Seven miles below outlet of Little Shuswap Lake.) Granite of fair quality comes out on the line of railway. (Report 1877-78, p. 165 B.)

On the Shuswap Lakes abundance of moderately good building stones, (granites and other cyrstalline rocks) occur, and stones which may be used for construction are also found at intervals along the line of railway eastward.

Lime and Cement.

Of limestones suitable for making lime, it is possible merely to mention a few localities in which lime has been burnt, or which appear to be so situated as to be of immediate importance.

Victoria.—Several beds of limestone occur here in metamorphic rocks, and a little lime has been made from them from time to time, but the stone is to impure to afford a good lime.

Saanich.—Limestones affording excellent lime found in several places and burnt for use in Victoria.

Texada Island.—The northern part of the island, already mentioned as a locality of marble, affords abundance of excellent material for the manufacture of lime, and is readily accessible, (see p. 109 B.)

Near Agassiz Station, C.P.Ry.—Limestone occurs here. Of specimens of three varieties examined in the laboratory of the Survey, two proved sufficiently pure to make good lime. (Report 1888, p. 56 T.)

Near Popcum, Lower Fraser River.—Limestone, apparently of good quality, in a stream on north side of Cheam Mountain, situated about half a mile from the Fraser. Reported by Mr. A. Bowman.

Near Hope Station, C.P.Ry.—Limestone has been burnt here to a limited extent, at a place near Murphy's mine, about one mile above

Hope Station, and the same distance back from the railway. Lime has also been made about four miles above Hope, on the east side of the river, but was said to be impure.

About six miles above Yale.—Limestone or marble which has been burnt, but most of which is too siliceous to afford a good lime.

Near Forty-mile Post, Waggon Road, Fraser River.—Grey laminated limestone, about 100 feet thick and apparently of good quality. (Report 1877-78, p. 163 B.)

About seven miles above Spence's Bridge.—Limestone of good quality appears on the line of railway and also on the opposite side of the river, where it continues for several miles. (Report 1877-78, p. 163 B.)

North Thompson, six miles and a-half above Kamloops.—(East side of river.) Good limestone.

North Thompson, seventeen miles above Kamloops.—(West side of river, near Venn's.) Here and at several places a few miles further up, abundance of good limestone for burning.

South Thompson, ten miles above Kamloops.—(North bank.) Extensive exposures of good limestone. (Report, 1877-78, p. 80 B.) This and the two preceding localities are in communication by water with Kamloops, etc.

Shuswap Lakes.—Limestone suitable for burning in numerous places along the shores. (For details, see Report, 1877-78, p. 163 B.)

Qailchena, Nicola Lake.—(near mouth of McDonald River.) Good limestone, which has occasionally been used for the manufacture of small quantities of lime.

Near Stump Lake.—(a mile and a-half south from 'Palmer's,' on the hill.) Good limestone outcrops here, and may possess importance from its proximity to the Stump Lake mines.

For other occurrences of limestone in the southern interior of the Province, See Report, 1877-78. Limestones occur in great abundance and of good quality in that part of the Rocky Mountain range which is traversed by the railway. (Consult Reports, 1885. Part B., 1886, Part D.)

Near Skidgate, Queen Charlotte Islands.—Volcanic tuff resembling 'trass,' which may probably afford the basis of a hydraulic cement. (See p. 109 B.)

ORNAMENTAL AND PRECIOUS STONES.

The marbles included in the above enumeration, might be mentioned under the head of Ornamental Stones. For remarks on other materials see p. 108 B. *Such localities as might be noticed under Precious Stones are mentioned on pp.* 110 B, 111 B, *and need not here be repeated.*

Miscellaneous Minerals

Arsenic.—Native arsenic in considerable mass in veins seven miles up Watson Creek, west side of Fraser River, 25 miles above Lytton. (Report, 1886, p. 86 T.)

Bismuth.—In long prismatic crystals of the sulphide, in quartz. Little Shuswap Lake, north side, a mile and three-quarters from head of lake. (Report 1877-78, p. 162 B.)

Iron-pyrites.—Specimen of massive pyrites, said to occur in large quantity, brought from Copper Island, Barclay Sound.

Plumbago.—Large deposit of disseminated plumbago at Alkow Harbour, Dean Canal.

Plumbago.—Specimens obtained by the Vancouver Island Exploring Expedition in the country north-east of Port San Juan.

Nickel.—Nickeliferous sand obtained in gold-washings on the Fraser River, consists of magnetite, and pyritous grains attracted by the magnet, which consist of oxides of iron and nickel. (J. Blake, M.D., Proc. Cal. Acad. Sci., V. p. 200.)

Asbestus.—Thibert Creek, Cassiar. Specimens of a rather coarse and brittle variety of serpentine-asbestus.

Asbestus.—Stewart River, Yukon district. Small specimen of good serpentine-asbestus obtained. (Report, 1887, p. 27 B.)

Mica.—At a place about 120 miles north-east of Clinton, a large deposit of mica is said to occur. Specimens of good size have been brought out, but having been obtained from the surface, are somewhat weathered.

Mica.—In large crystals in veins traversing granites near the extremity of the north-east arm of Shuswap Lake, and may prove to occur of useful dimensions here or elsewhere in the same mountain region. (Report, 1877-78, p. 162 B.)

Nitre.—Filling cavities in a cavernous calcareous tufa on the Nazco River. (Report, 1875-76, p. 265.)

Nitre.—Specimens received from Big Bar, Fraser River, where it probably occurs under circumstances similar to the last.

Bitumen.—Oozing out on the beach. Tar Islands, Queen Charlotte group. (Report, 1878-79, p. 60 B.)

Amber.—A rounded fragment found in possession of the Indians, and said to be derived from the west coast of the Queen Charlotte Islands. (Report, 1878-79, p. 85 B.)

MINERAL AND THERMAL SPRINGS.

Nanaimo.—Salt spring. Issues from the Cretaceous co
strata near the Douglas seam, and according to Mr. Richard
flow of two to three gallons a minute. The Hudson Bay Co
one time attempted the manufacture of salt here, but it
abandoned. The brine has been analyzed by Mr. Hoffmann,
it to contain 52·154 parts of saline matter in 1000. Of this t
parts were common salt and the remainder largely calcium
According to an analysis quoted by Pemberton, it contained
of salt in 1000 in 1854. (Report 1872-73, p. 82. Facts an
relating to Vancouver Island, etc., p. 159.)

Admiralty Island.—Salt spring. According to analysis q
Pemberton in the place above cited, the spring contains 65
saline matter to 1000, but with more impurities than the last

Harrison Lake.—Hot springs, known as "St. Alice's Well."
ing to Dr. Selwyn there are two principal springs, with tem
of 120° to 150° F. respectively, and both copious. The wate
analysed in the laboratory of the Survey and the results will
the annual report for 1888.

Near Lillooet River.—About five miles from head of Harri
Hot Spring, known as "St. Agnes' Well," no particulars.

Near Upper Columbia Lake.—Hot spring. At about two mi
the lower end of the lake, on a hill on the east side of th
Estimated to yield about twenty gallons a minute, at a tempe
112° F. The outflow produces a calcareous deposit. A qualitat
sis has been made by Mr. E. B. Kenrick. (Reports 1885,
1886, p. 15 T.)

Sinclair Pass.—Rocky Mountains. Hot springs, on sout
Berland's Brook, near the point at which it issues from the m
into the Upper Columbia valley. Three springs reported, and
copious. Mr. John McKay, who discovered these springs,
temperature of one as 108° F., of another as 118° F.

Elk River Valley.—Rocky Mountains, about Lat. 50°
sulphur-spring reported on east side of river by Mr. H. M. H

Kootanie Lake.—Hot springs, giving its name to the "Ho
Mining Camp." Situated on west side of lake, directly opp
"Blue Bell Claim." Several springs occur near the edge of
and some below the water-level. Temperature estimated
100° F.

Upper Arrow Lake.—Hot spring. On the east side of
twelve miles from its head, and one hundred and fifty yards
lake. Said to be about as hot as can comfortably be borne in

Albert Cañon Station C. P. Ry.—Hot spring. About a mile to the north of the Station. Temperature about the same as the last.

Near Upper Arrow Lake.—Hot spring reported by Indians at some distance back from the lake, on the flat land at the west side of the lake, three or four miles from its southern end.

Near Albert Cañon Station.—'Soda spring.' One mile and a half west of the station on south side of the track. This and the following springs are known as 'soda springs' in consequence of the presence of large quantities of carbonic acid gas.

Near Carne's Creek.—On west side of Columbia River and opposite the mouth of Carne's Creek. Group of springs with copious escape of carbonic acid gas.

Near Downie Creek.—'Soda spring.' Is situated about three-fourths of a mile north-west of the trail from Downie to Gold Creek and about four miles from the latter.

Four miles above Smith's Creek.—West side of Columbia River. Springs with considerable escape of carbonic acid gas, and deposition of iron-oxide, reported.

Skeena River.—Left bank, about fourteen miles above "Inverness Cannery." Hot spring No particulars.

Stikine River.—Hot spring. Situated a short distance above Buck's Bar and directly opposite the Great Glacier. No particulars.

Kennicot Lake.—At head of south branch of Taku River. Hot spring. Said to feed the lake. (Alaska and its Resources. Dall. p. 628.)

Hot Spring Island.—Queen Charlotte Islands. Hot springs with a slight smell of sulphureted hydrogen and a barely perceptible saline taste. Temperature over 100° F. (Report 1878-79 p. 22 B.)

Vermilion River.—Vermilion Pass, Rocky Mountains. About six miles west of the summit, on the north side of the valley, copious chalybeate springs, depositing ochre, from which the name of the pass is derived. (Report 1885, p. 120 B.)

Maiden Creek.—"Dougherty's spring." South of Clinton, and about three miles up the stream from the waggon-road crossing. Mineral spring, highly charged with carbonic acid, which escapes in such large quantity as to prove fatal to small birds approaching the spring. A qualitative analysis by Mr. Kenrick. (Report 1886, p. 13 T.)

McDonald's 'Oil Spring.'—Head-waters of Omenica River, lat. 56°. This spring is marked as above on Trutch's map of British Columbia. It is not, however, an oil spring, but is described as a small mound in the centre of which a hollow exists charged with carbonic acid to such an extent as to prove fatal to birds and small mammals.

Spallumsheen Arm.—Shuswap Lake. A spring known to the Indians as Pilpilpoopil, issues near shore of lake. Gas or air escapes with the water in considerable quantity. (Report 1877-78, p. 25 B.)

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON THE

MINING & MINERAL STATISTICS

OF CANADA

FOR THE YEAR 1887;

BY

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Mining Engineer of the Geological Survey of Canada.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

To ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I have the honor to forward herewith my report on the mining and mineral statistics of Canada for the year 1887.

As regards silver, iron ore, phosphate and pyrites, the statistics are supplemented by short notices giving details of the recent developments at the mines or of the mode of occurrence of the deposits.

The report "on Canadian Precious Stones" was kindly supplied by Mr. George F. Kunz, of New York, to whom our best thanks are due.

Cordial thanks are also due for the uniform courtesy and kind assistance accorded us in our inquiries for statistics, and I desire to mention especially in this connection the Departments of Mines of Nova Scotia and of British Columbia, and the Department of Customs at Ottawa. The help afforded me by my assistant, Mr. H. P. Brumell, of the Geological Survey, was very efficient, and deserves also a specal mention.

I am, Sir,

Your obedient servant,

E. COSTE.

JUNE, 1888.

NOTE.—Throughout this report the ton is of 2,000 lbs., and year the calendar year, unless otherwise specified

The fiscal year begins on the 1st of July.

SUMMARY OF THE MINERAL PRODUCTION OF CANADA IN 1887.

Name of Product.		Quantity.	Value
Antimony ore	tons.	584	$ 10,860
Arsenic	"	30	1,200
Asbestus	"	4,619	226,976
Baryta	"	400	2,400
* Bricks	thousands.	181,581	986,689
* Building stone	cub. yds.	262,592	552,267
Cement	bbls.	69,843	81,909
Charcoal	bush.	1,610,900	88,823
Chromic iron ore	tons.	38	570
Coal	"	2,368,891	4,768,590
Coke	"	40,428	135,951
Copper	lbs.	3,260,424	343,345
* Fertilizer	tons.	498	25,943
* Flagstone	sq. ft.	116,000	11,600
Gold	ozs.	66,270	1,178,637
Granite	tons.	21,217	142,506
Graphite	"	300	2,400
Grindstone	"	5,292	64,008
Gypsum	"	154,008	157,277
* Iron	"	91,527	1,087,728
Iron ore	"	76,330	146,197
Lead (fine, contained in ore)	lbs.	204,800	9,216
* Lime	bush.	2,269,087	394,859
Limestone for iron flux	tons.	17,171	17,500
Manganese ore	"	1,245	43,658
* Marble and Serpentine	"	242	6,224
Mica	lbs.	22,083	29,816
* Mineral Paint	tons.	100	1,500
* Miscellaneous clay products		....	182,150
* Moulding sand	tons.	160	800
Ochre	"	385	2,233
Petroleum (a)	(bbls. of 35 imp. gals.)	763,933	595,868
Phosphate	tons.	23,690	319,815
Pig Iron	"	24,827	366,193
Platinum	ozs.	1,400	5,600
Pyrites	tons.	38,043	171,194
Salt	"	60,173	166,394
Silver		....	349,330
Slate	tons.	7,357	89 000
Soapstone	"	100	800
Steel	"	7,326	331,199
Sulphuric acid	lbs.	5,476,950	70,609
* Tiles	thousands.	14,658	230,068
Whiting	tons.	75	600
Estimated value of mineral products not returned		abt.	1,610,499
Total		abt.	$16,000,000

* Incomplete.

(a) The total given by the direct returns from the refineries was finally adopted as the most correct.

EXPORTS OF MINERALS AND MINERAL PRODUCTS MINED OR MANUFACTURED IN CANAD[illegible] DURING THE YEAR 1887

ARTICLES.	VALUE.	ARTICLES.	VALUE.
Antimony ore	$ 9,720	Forward	$3,651,01[illegible]
Asbestus	158,839	Manganese ore	34,8[illegible]
Coal	1,696,783	Mica	3,4[illegible]
Copper ore	109,336	Oil, mineral, coal & kr'sne.	13,8[illegible]
" fine	29,100	Phosphates	433,2[illegible]
Glass and glassware	1,030	Plumbago	3,0[illegible]
Gold	920,329	Salt	11,5[illegible]
Grindstones	28,769	Sand and Gravel	30,3[illegible]
Gypsum	146,542	Silver	205,8[illegible]
" ground	13,963	Slate	1,3[illegible]
Iron & Steel, all sorts, abt.	412,000	Stone & Marble, unwrought	53,9[illegible]
Iron ore	42,634	" " wrought	14,0[illegible]
Lead ore	724	Other articles	212,9[illegible]
Lime and Cement	82,261		
Forward	$3,651,010	Total	$4,669,3[illegible]

EXPORTS OF MINERALS AND MINERAL PRODUCTS MINED OR MANUFACTURED IN CANAD[illegible] DURING THE FISCAL YEAR 1887

FORWARDED TO	VALUE.	FORWARDED TO	VALUE.
United States	$3,358,005	Forward	$4,264,6[illegible]
Great Britain	623,216	Belgium	6,6[illegible]
Newfoundland	150,000	Japan	5,2[illegible]
Germany	46,851	France	5,0[illegible]
Sandwich Islands	27,664	British East Indies	4,6[illegible]
St. Pierre	15,978	Chili	4,3[illegible]
Australia	12,356	British Africa	2,0[illegible]
Argentine Republic	11,879	China	1,1[illegible]
British West Indies	9,966	Other countries	4,7[illegible]
Spanish " "	8,721		
Forward	$4,264,636	Total	$4,300,4[illegible]

IMPORTS OF MINERALS AND OF PRODUCTS CHIEFLY MANUFACTURED THEREFROM DURING 1887.

Articles.	Value.	Articles.	Value.
Alum & aluminous cake	$ 22,148	Forward	$23,727,320
Antimony	6,479	Lime	8,090
Arsenic	1,541	" chloride of	53,472
Asbestus, mfrs. of	8,489	Litharge	28,705
Asphaltum	9,403	Lithographic stones	6,369
Baryta	276	Manganese, oxide of	3,169
Borax	19,891	Marble	92,958
Brass, and mfrs. of	501,367	Mercury	16,396
Bricks	15,502	Mineral waters	38,771
" and Tiles, Fire	[illegible]	Ornamental stones	21,811
Buhrstones	[illegible]	Paints	534,451
Building stone	73,291	Petroleum	435,481
Cement	12,138	Plaster of Paris	5,632
" Portland	169,469	Platinum	1,636
Chalk	5,223	Potash salts	21,860
Clays, all sorts	50,980	Precious stones	259,328
Coal "	9,547,052	Salt	286,676
Copper, and mfrs. of	315,959	Sand and Gravel	30,508
Copperas	5,741	Slate	25,214
Earthenware	207,847	Soda salts	304,109
Emery and Pumice	16,527	Spelter	22,250
Emery wheels	3,425	Sulphur	31,616
Fertilizers	43,745	Sulphuric acid	39,210
Flagstones	20,269	Tiles, drain & sewer pipes glazed	90,380
Glass and Glassware	1,234,522	Tiles, all others	7,449
Graphite, and mfrs. of	14,044	Tin, and mfrs. of	938,737
" Pencils	62,338	Whiting	19,360
" Blacklead	16,876	Yellow metal	42,965
Grindstones	19,274	Zinc, and mfrs. of	83,263
Iron, Pig Iron and Steel, all sorts, about	11,000,000		
Lead, and mfrs. of	257,640		
Forward	$23,727,320	Total	$27,166,966

ABRASIVE MATERIALS.

Grindstone.

Grindstone was the only abrasive material for which returne received for the year 1887. Small quantities of infusorial eart whetstones from Canadian deposits were probably also markete ing the year, but particulars have not been obtained. As to e corundum, buhrstones, pumice stone, and other abrasive mater is believed that no quantity has ever been obtained comme from deposits in Canada.

Summary.

The total production of grindstones during the year was 5,292 valued, manufactured, at the quarries, at $64,008. This is an in of 1,292 tons, and $17,463, over the returns of 1886, but as the r last year were incomplete, this does not show the real incre production.

Production by provinces.

The above production was from the provinces of New Bru and Nova Scotia, respectively, as below :—

	Quantity.	Value mfd. quarries.
New Brunswick, 7 producers	3,582 tons.	$38,988
Nova Scotia, 2 producers	1,710 tons.	$25,020

Exports and imports.

The following tables show the exports and imports of grindsto well as the imports of buhrstone, emery and pumice stone :—

EXPORTS OF GRINDSTONE.

PROVINCE.	1886.	1887.
Ontario	......	$ 500
Quebec	$ 1	12
Nova Scotia	9,400	10,425
New Brunswick	14,784	17,832
Totals	$24,185	$28,769

IMPORTS OF GRINDSTONE

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	862	$ 9,587	1,355	$13,718
Quebec	222	2,718	143	4,676
Nova Scotia	....	69	....	35
Manitoba	30	832	30	468
British Columbia	18	488	9	479
Totals	1,132	$13,694	1,736	$19,374

IMPORTS OF BURRSTONE

Province.	1886.		1887.	
	No.	Value.	No.	Value.
Ontario..................	618	$1,203	366	$1,184
Quebec....................	....	696	1,865	2,325
British Columbia	....	......	....	26
Totals..............	....	$1,899	....	$3,535

IMPORTS OF EMERY AND PUMICE STONE

Province.	1886.	1887
Ontario..........................	$10,461	$10,781
Quebec...........................	3,235	3,968
Nova Scotia....	103	360
New Brunswick...............	1,250	1,413
Manitoba	1	1
British Columbia.............	33	2
Prince Edward Island.........	12	2
Totals..................	$15,085	$16,527

IMPORTS OF EMERY WHEELS

Province.	Value
Ontario	$ 759
Quebec..........................	1,831
Nova Scotia.....................	60
New Brunswick.............	642
Prince Edward Island.......	4
Manitoba.......................	55
British Columbia............	74
Total........	$3,425

ANTIMONY.

Summary.

The antimony ore in 1887 was nearly all produced in Nova only 34 tons having been exported from the Lake George min Co., N.B., which was not worked during the year. Some atory work was done at the Lake Nicolet mine, South Ham, The total production was 584 tons, valued at $10,860.

Nova Scotia.

According to Mr. Gilpin's report to us, the production in Scotia, at the Rawdon mines, was 550 tons, worth at the min $18 per ton, or $9,900. This shows a great decrease in the v the ore, and a poorer quality of ore obtained than during last y

Exports and imports.

The tables of exports and imports are appended.

EXPORTS OF ANTIMONY ORE, YEAR 1887.

TABLE 1

PROVINCE	Tons.	Value.
Nova Scotia (a.)	195	$8,760
New Brunswick (b.)	34	960

(a.) Shipped to Great Britain.
(b.) " " United States.

IMPORTS OF ANTIMONY, YEAR 1887.

TABLE 2

PROVINCE.	Pounds.	Value.
Ontario	47,880	$3,551
Quebec	28,343	2,746
Nova Scotia	112	8
New Brunswick	2,016	174
Totals	78,351	$6,479

ARSENIC.

There were 30 tons only of refined arsenic shipped during the year 1887 from the Deloro mine, Ontario, compared with 120 tons in 1886. The value of this shipment at the mine was $1,200, or $40.00 per ton, and the cost of placing it on the New York market was $7.50 per ton. Only a small quantity was sold in the crude state. Summary.

Analyses of this arsenious oxide are appended :— Analyses.

Mean of a car load by P. de P. Rickets, Columbia College................ } As_2O_3 99.84; impurities, 0.16; 100.00

By Baker Edwards of Montreal....... } Refined arsenic, 97.5 As_2O_3; Crude arsenic, 92.8 "

Much more of this practically pure arsenic could be manufactured at this mine as the ore, which contains also a considerable percentage of gold, is very rich in mispickel or arsenical sulphuret of iron. The United States market requiring from 1,500 to 2,000 tons every year, according to the statistics of imports of that country and the Deloro arsenic having been well received in the United States, there seems to be no reason why the Deloro mine should not supply at least a much larger proportion of the demand of that country.

No other mine in Canada produced arsenic in 1887.

The following table gives the imports for 1886 and 1887 :— Imports.

Province.	1886.		1887.	
	Pounds	Value.	Pounds.	Value.
Ontario............	12,741	$351	13,136	$ 456
Quebec.............	12,828	533	26,536	937
Nova Scotia........	2,412	85	3,837	144
New Brunswick. ...	......	....	100	4
Manitoba...........	200	10	......	....
Totals........	28,181	$979	43,609	$1,541

ASBESTUS.

Summary.

According to the direct returns received, the total quantity of a tus marketed during the year in Canada was 4,619 tons, valued a mines at $226,976. This shows an increase of 1,161 tons in quan and $20,725 in value, over the returns of 1886.

Statistics of previous years.

In the report for 1886 a table was given of the shipments of asb from Canadian mines since the first production in 1879; this table made up from the returns furnished by the producers. We have been favored by Mr. James R. Woodward, General Manager of Quebec Central Railway, with the following table of the asbestus ments from Thetford and Black Lake stations:—

Fiscal years.	Tons.
—	
1882	410
1883	724
1884	1,101
1885	1,327
1886	1,882

If to this is added 900 tons to cover all the shipments before 30th 1881, plus about 1,500 tons shipped in the second half of the 1886, and 515 tons which were delivered from other mines and included in the table of the last report, we have a total of 8,362 to compare with the total of 10,024½ tons given in the 1886 report. shows the figures in the table above referred to to be about 16 per too high, the producers, probably, sometimes returning the output not the quantities shipped.

Production by provinces. Quebec.

Except 400 tons the whole is from Quebec, and mined by ten d ent producers at Thetford, Black Lake, Danville and Coleraine. shipments from Thetford mines and Black Lake mines were 3,661 according to the direct returns received, while a detailed staten kindly supplied by Mr. Woodward, give 3,513 tons as follows:—

Thetford Mines	2,560 tons
Black Lake "	953 "

Ontario.

In Ontario 400 tons of a somewhat different article, valued at $6 at the mill, and used principally for asbestos roofing, were prod by Messrs. James & Taylor, of Bridgewater.

The following table 1 represents only the exports from 1st of July to the end of the year, as before that date there was no separate entry for asbestus in the returns of the Customs department. Table 2 gives the imports of the manufactured article :— Exports and imports.

EXPORTS OF CRUDE ASBESTUS DURING THE SECOND HALF OF 1887.

TABLE 1.

Quality.	Tons.	Value.
1st class Asbestus..........	1,761	$130,707
2nd " "	566½	23,296
3rd " "	184	4,826
Total half year 1887....	2,511½	$158,829

IMPORTS OF MANUFACTURED ASBESTUS, YEAR 1887.

TABLE 2.

PROVINCE.	Value
Ontario	$3 485
Quebec	3,848
Nova Scotia..............	312
New Brunswick..............	576
Manitoba	32
British Columbia..............	246
Total..	$8,489

COAL.

The total production of coal in 1887 was 2,368,891 tons, valued at the points of production at $4,758,590 Total production and comparison with 1886.

This is an increase, as compared with the returns of 1886, of 276 915 tons, and $741,365, but as the production in New Brunswick and in Manitoba is included in the returns of this year and were not last year, the real increase in the other districts, that is :—in Nova Scotia, the North west Territories, and British Columbia, is 266,475 tons, and $717,358, or from 12 to 17 per cent

Production by provinces.

The following table gives the total production of each province:—

PRODUCTION OF COAL DURING 1887, BY PROVINCES.

Province.	Tons.	Value at mine.	No. of men employed.	No. of Prd'cers.
Nova Scotia	1,871,338	$2,923,966	4,367	20
British Columbia..	413,360	1,653,440	1,463	8
North West Terr..	73,752	156,777	321	10
New Brunswick...	10,040	23,607	110	16
Manitoba	400	800	4	1
Totals........	2,368,890	$4,758,590	6,265	50

Nova Scotia

Tables A, B, C and D, taken from the report of the Inspector of Mines, give the details of the production and of the sales of coal in Nova Scotia in 1887; table E, from the same source gives the yearly production since 1870.

PRODUCTION, SALES AND COLLIERY CONSUMPTION OF COAL IN NOVA SCOTIA DURING THE YEARS 1887, 1886, 1885 AND 1884.

TABLE A.

Period.	Production.	Sales.	Colliery consumption.
1887 First quarter, tons..	230,948	155,472	34,992
1887 Second " " ..	474,840	421,315	47,696
1887 Third " " ..	626,480	629,040	34,036
1887 Fourth " " ..	539,070	496,219	39,826
Totals............	1,871,338	1,702,046	156,550
1886 "	1,682,924	1,538,504	159,512
1885 "	1,514,470	1,405,051	142,939
1884 "	1,556,010	1,413,048	130,781

DISTRIBUTION OF NOVA SCOTIA COAL SOLD DURING THE YEAR 1887.

TABLE B.

Market.	Tons.
Nova Scotia :—	
Transported by land	297,926
" by sea	227,874
Total	525,800
New Brunswick	208,892
Newfoundland	91,899
Prince Edward Island	56,639
Quebec	728,961
West Indies	6,877
United States	82,759
Other countries	169
Total	1,702,046

COAL TRADE BY COUNTIES IN NOVA SCOTIA DURING THE YEAR 1887

TABLE C.

Year 1887.	Cumberland.		Pictou.		Cape Breton.		Other counties.		Total	
	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Raised	Sold
First Quarter	112,712	103,141	50,133	44,239	68,104	8,091			230,949	155,471
Second "	140,880	132,167	87,132	71,425	246,827	217,723	...	....	474,839	421,315
Third "	146,600	138,156	145,963	134,592	335,916	356,291			628,479	629,[illegible]
Fourth "	159,217	147,501	117,806	120,462	231,876	219,190	112	67	539,171	496,220
Totals.	569,408	520,965	431,094	379,718	880,723	801,295	112	67	1,871,358	1,702,045

PRODUCTION OF COAL IN NOVA SCOTIA BY COLLIERIES DURING 1887

TABLE D.

	Colliery.	Tons.	Colliery.	Tons.
Cumberland Co.	Chignecto	18,456	Forward	1,141,798
	Joggins	18,647	Francklyn	6,073
	Lawson	134	Glace Bay	89,058
	Spring Hill	522,170	Gowrie	143,894
Pictou Co.	Acadia	258,284	International	122,532
	Barton	364	Ontario	8,700
	East River	1,282	Reserve	99,511
	Intercolonial	171,164	Sydney	191,276
Cape Breton Co.	Blockhouse	8,597	Victoria	68,384
Inverness Co.	Bridgeport	21,577	Mabou	112
	Caledonia	121,121	Total	1,871,338
	Forward	1,141,798		

YEARLY PRODUCTION OF COAL IN NOVA SCOTIA SINCE 1870

TABLE E.

Year.	Tons.	Year.	Tons.
1870	700,861	1880	1,154,63[illegible]
1871	754,031	1881	1,259,182
1872	984,664	1882	1,539,708
1873	1,117,643	1883	1,593,259
1874	977,446	1884	1,556,010
1875	874,905	1885	1,514,470
1876	794,603	1886	1,682,924
1877	848,395	1887	1,871,338
1878	863,081	Total	21,024,218
1879	682,863		

The following tables F & G, compiled from the reports of the Minister of Mines of British Columbia, show respectively the details of the coal trade there in 1887, and the yearly output since 1874:—

COAL TRADE OF BRITISH COLUMBIA DURING THE YEAR 1887.

TABLE F.

Name of colliery.	Coal raised.		Sold for home consumption.		Sold for exportation.	On hand January 1st, 1887		Unsold, including coal in stock, Jan. 1st 1888.		Number of men employed.
	Tons.	cwts.	Tons.	cwts.	Tons.	Tons.	cwts.	Tons.	cwts.	
Nanaimo.....	138,712	11	23,491	12	114,815	882	10	1,288	9	618
Wellington ..	239,217	4	72,464	4	187,193	20,711		271		715
E. Wellington.	35,431		1,000		32,831	2,000		1,340		130
Totals..	413,360	15	96,955	16	334,839	23,593	10	2,899	9	1,463

PRODUCTION OF COAL IN BRITISH COLUMBIA FROM 1874 TO 1887 INCLUSIVE

TABLE G.

Year.	Tons.
1874	81,000
1875	110,000
1876	139,000
1877	154,000
1878	171,000
1879	241,000
1880	268,000
1881	228,000
1882	282,000
1883	213,000
1884	394,070
1885	365,000
1886	326,636
1887	413,360

Returns have been received from ten different producers of coal in the North West Territories, and the total of their production for 1887 was 73,752 tons valued at the mines at $156,777. This, it is believed, represents the total production of the Territories within about 200 tons. It was mined at Lethbridge, Anthracite, Bow River Coal Mine near Cochrane Station, and near Edmonton. This is an increase of about 30,000 tons over the production of 1886. North West Territory.

From New Brunswick 15 returns were received, all from the Grand Lake district, representing 8,360 tons sold for $20,247 at the mines. Estimating the total missing returns at about 1,200 chaldrons, or 1,680 tons, we have about 10,000 tons as a close estimate of the total production. As coal mining in New Brunswick is only done in a desultory way, it is therefore very difficult to obtain more complete statistics. New Brunswick.

Exports and imports.

The total exports during 1887 were 670,063 tons, of which 89,098 tons were foreign coal previously imported.

The imports amounted to 1,440,152 tons of anthracite and 1,218,333 tons of bituminous coal, which shows a remarkable increase of 47 per cent in the importations of anthracite, due, no doubt, to the removal of the duty.

The following tables 1, 2 and 3, give respectively the exports by Provinces in 1886 and 1887, the exports from Nova Scotia and British Columbia since 1874, and the imports of anthracite and bituminous coal in the last two years by provinces :—

EXPORTS OF COAL (FOREIGN & CANADIAN) BY PROVINCES IN THE YEARS 1886 & 1887.

TABLE 1.

1886.

Province.	Canadian.		Foreign.	
	Tons.	Value.	Tons.	Value.
Ontario..........	367	$ 1,299	49,469	$119,853
Quebec	5,126	21,432	20,342	38,092
Nova Scotia.......	240,459	441,693	5	25
New Brunswick...	17	162	8,610	33,038
Manitoba	......	......	......	......
British Columbia..	274,466	960,649	......	......
P. E. Island......	268	601	17	51
Totals......	520,703	$1,425,836	78,443	191,058

1887

Province.	Canadian.		Foreign.	
	Tons.	Value.	Tons.	Value.
Ontario..........	......	......	67,837	$170,754
Quebec	14,737	$ 37,772	15,188	23,413
Nova Scotia.......	207,941	390,738	3,303	9,297
New Brunswick...	1,341	4,025	2,270	7,486
Manitoba.........	15	60	......	......
British Columbia..	356,657	1,262,552	......	......
P. E. Island.......	274	636	......	......
Totals......	580,965	$1,595,783	89,098	$210,950

EXPORTS OF COAL FROM NOVA SCOTIA AND BRITISH COLUMBIA (THE PRODUCE OF CANADA) FROM 1874 to 1887, INCLUSIVE.

TABLE 2.

Year.	Nova Scotia		British Columbia	
	Tons.	Value.	Tons.	Value.
1874	252,124	$647,539	51,001	$ 278,180
1875	179,628	404,351	65,842	356,018
1876	126,520	263,543	116,910	627,754
1877	173,389	352,453	118,252	590,263
1878	154,114	293,795	165,734	698,870
1879	113,742	203,407	186,094	608,845
1880	199,552	344,148	219,878	775,008
1881	193,081	311,721	187,791	622,965
1882	216,954	390,121	179,552	628,437
1883	192,795	336,088	271,214	946,271
1884	222,709	430,330	245,478	901,440
1885	176,287	349,650	250,191	1,000,764
1886	240,459	441,693	274,466	960,649
1887	207,941	390,738	356,657	1,262,552
Totals..	2,649,293	$5,159,577	2,689,060	$10,258,016

IMPORTS OF ANTHRACITE AND BITUMINOUS COAL BY PROVINCES IN 1886 AND 1887.

TABLE 3.

Province.	1886.				1887.			
	Anthracite.		Bituminous Coal.		Anthracite.		Bituminous Coal.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario....	649,394	$2,755,291	937,983	$2,541,140	1,042,077	$4,456,827	1,138,270	$3,226,524
Quebec........	267,286	957,740	75,864	136,465	340,046	1,315,390	75,324	147,890
Nova Scotia......	18,803	59,550	1,243	5,963	21,909	79,[illegible]04	1,131	7,135
New Brunswick..	34,845	111,269	8,922	17,535	33,833	126,449	3,102	7,607
Manitoba........	3,437	15,800	60	289	2	23	1,832	4,345
British Columbia.	26	407	589	3,138	112	1,737	665	5,259
P. E. Island.....	1,747	4,975	36	71	2,673	9,050	..	
Totals...	975,528	$3,905,026	1,024,702	$2,705,304	1,410,152	$5,990,283	1,218,833	$3,398,760

Coke

Returns received from the Londonderry Iron Works and from the Albion Mines, Nova Scotia, show the quantity manufactured by these two companies to have been 40,428 tons, valued at the ovens at $135,951. 162 ovens were in fire, and the number of men employed was about 60. Coke ovens were built in December, 1887, at Cow Bay, Cape Breton, and have been in fire since, but had not produced during the year to which these statistics refer.

The following table gives the imports of coke for the last three years:—

IMPORTS OF COKE DURING THE YEARS 1885, 1886 AND 1887.

PROVINCE.	1885		1886		1887	
	Tons.	Value.	Tons.	Value.	Tons.	Value
Ontario	9,860	$33,681	11,140	$38,406	15,981	$67,797
Quebec	1,682	5,118	2,132	7,510	3,696	13,849
New Brunswick..	......	......	2	11	......	......
Manitoba	34	237	163	1,150	43	260
British Columbia.	253	1,041	105	364	85	429
Totals....	11,829	$40,077	13,542	$47,441	19,805	$82,335

Charcoal

The production of charcoal is estimated to have been in 1887, abou 1,610,900 bushels, worth at the kilns about $88,823. Of this 940,40 bushels were used in the manufacture of pig iron at the Radnor an Drummondville Blast Furnaces, and about 670,500 bushels were manu factured in the County of Essex for exportation to iron works in th United States.

COPPER.

Summary

The total marketed production of copper in 1887 in Canada wa according to the returns received, 40,800 tons of ore containin 3,260,424 lbs* of fine copper, valued, at the average market price fo the year of 10½ cts., at $342,345.

This, compared with the 1886 production, shows a decrease of 344,57 lbs., principally due to the fact that the largest of the producers Messrs. G. H. Nichols & Co., were extensively engaged during the yea in constructing a new mining plant and sulphuric acid works.

* Quantity of fine copper manufactured from the ore of Capelton plus copper contents calcu lated from assay value in the other returns.

Production by districts.

The 1887 production was mined :—at Capelton, in Quebec ; at the Sudbury mines, in Ontario ; and at the Goodfellow mine, in Albert Co., New Brunswick. The larger part, viz. :—38,773 tons, with a copper content of 2,937,900 lbs., was from the Albert and Crown mines of Capelton. At Coxheath mines, in Nova Scotia, a little exploratory level driving was done, but no returns of ore shipment were made to the Inspector of Mines at Halifax.

Exports and Imports.

There being no copper works in Canada, the whole of the production was exported principally to the United States, and as follows, according to the returns of the Customs Department :—

Province.	Quantity.	Declared Value.	Destination.
Ontario	567 tons of ore.	$ 3,416	U. S.
Quebec .... {	1,015½ " " ore.	13,550	G. B.
	1,210 " " fine copper.	121,000	U. S.
Nova Scotia	6 " probably matte.	270	G. B.
New Brunswick...	2 " " "	300	G. B.

The following Table 1 gives the exports from Quebec and Ontario for the last four years as per corrected Customs Department returns, and Table 2 shows that the export returns at Stanstead, our principal port of export for copper ore, are constantly lower than what is really exported, and consequently is a proof that in Table 1 the figures in Quebec should be greater.

EXPORTS OF COPPER FROM ONTARIO AND QUEBEC.

(From details furnished by Customs Department).

TABLE 1

Year.	Quebec.		Ontario.		Total.	
	Pounds	Value	Pounds.	Value.	Pounds.	Value.
1884	2,714,400	$273,422			2,714,400	$273,422
1885	2,626,000	262,600			2,626,000	262,600
1886	2,736,630	232,855	164,040	$16,404	2,900,670	249,259
1887	2,555,500	134,550	34,160	3,416	2,589,660	137,966

COMPARATIVE STATEMENT OF COPPER CONTENTS OF SAME QUANTITIES OF CANADIAN ORES EXPORTED TO THE UNITED STATES.

TABLE 2.

Fiscal Years.	Imported to Vermont as per U. S. Treasury Department Returns.		Exported from Stanstead as per Canadian Customs Department Returns.		Difference.	
	Pounds of Copper.	Value.	Pounds of Copper.	Value.	Pounds of Copper.	Value.
1884	2,234,642	$223,405	1,676,000	$171,700	558,642	$51,705
1885	2,943,736	294,413	2,452,000	245,200	491,736	49,213
1886	3,318,723	332,033	2,590,000	267,340	728,723	64,693
1887	3,064,337	170,523	2,770,000	161,200	294,337	9,323

The imports in 1886 and 1887 were as below :—

IMPORTS OF COPPER.

(From Customs Department Books)

PROVINCE.	1886.			1887.		
	Pigs, bars, ingots, old, &c.		Manufactured.	Pigs, bars, ingots, old, &c.		Manufactured.
	Pounds.	Value.	Value.	Pounds.	Value.	Value.
Ontario......	1,159,200	$121,994	$29,162	1,121,400	$120,204	$35,768
Quebec	1,146,100	64,349	16,623	794,600	67,855	56,700
Nova Scotia...	64,100	4,523	3,483	37,500	3,054	11,231
N. Brunswick.	66,200	4,547	4,123	54,200	5,153	6,644
P. E. Island.	3,800	480	112	1,000	119	82
Manitoba.....	......	......	4,768	2,100	242	2,642
B. Columbia..	4,400	653	4,508	16,200	1,900	4,365
Totals....	2,443,800	$196,846	$62,768	2,027,000	$196,527	$117,432

GOLD.

The total production in 1887 was 66,271 ozs., valued at $1,178,637. About 3250 men were employed in gold washing or gold mining during the year. This production compared with that of 1886 shows a decrease of 10,608 ozs. and of $151,805 or a decrease in the value of 11 per cent, which is principally due to a falling off in British Columbia of about 23 per cent.

Production by provinces.

By provinces the above total quantity would be divided as follows :—

Province.	Oz. dwt. grs.	Value.	No. of men employed.
		$	
British Columbia......	40,856—8—5	694,559 (a)	2,379
Nova Scotia..........	21,211—17—18	413,614	578
Ontario..............	450—7—0	6,760	15
North West Terr...... (includ. Yukon dist).	3,660—5—0	62,100	256
Quebec	90—18—10	1,604	22
Total	66,270—16—9	$1,178,637	3,250

(a) A small amount of bullion obtained at one of the quartz mines is added to the total $693,709 given in the Minister of Mines' annual report.

The statistics for British Columbia are from the annual report of the Minister of Mines of that province, and are as follows :—

British Columbia.

Table A is the statement of the gold exported by the banks at Victoria during the year.

Table B gives the gold returns as estimated by the Gold Commissioners of the different district.

Table C shows the yearly yield of gold in the province since 1858.

VALUE OF GOLD EXPORTED AT THE BANKS AT VICTORIA DURING THE YEAR 1887.

TABLE A.

Bank of British Columbia..............................	$320,794
Bank of British North America........................	58,774
Garesche, Green & Co.................................	199,356
	$578,924

PRODUCTION OF GOLD AND NUMBER OF MINERS EMPLOYED IN BRITISH COLUMBIA DURING 1887, AS ESTIMATED BY THE GOLD COMMISSIONERS.

TABLE B.

Districts.	Divisions.	Whites.	Chinese.	Yield of gold by divisions.	Total yield by districts.
Cariboo	Barkerville	89	201	$ 79,373	
	Lightning Creek	28	163	30,700	
	Quesnel Mouth	10	127	51,000	
	Keithley Creek	27	211	66,600	$227,673
		154	702		
Cassiar	Laketon	24	53	1,4[illegible]0	
	McDame Creek	8	52	2[illegible]775	
	Skeena	17	4	5[illegible]80	60,485
		49	109		
Kootenay	Northern	100	20	8,550	
	Southern	13	62	29,350	37,900
		113	82		
Lillooet	....	50	400	106,000	106,000
Omineca	....	12	18	13,000	13,000
Yale	Hope, Yale and Lytton ...	......	200	20,000	
	Kamloops	6	16	5,200	
	Okanagan	9	30	5,000	
	Similkameen	102	325	128,000	158,200
		117	571		$603 258
	Total Whites	495	......		
	" Chinese	.....	1882		
	Total employed	2,377			

ANNUAL PRODUCTION OF GOLD IN BRITISH COLUMBIA SINCE 1858.

TABLE C.

Year.	Amount actually known to have been exported by banks, &c.	Add one-third more, estimate of gold carried away in private hands.	Total.	Number of miners employed.	Average yearly earnings per man.
1858 (6 months.)	$ 390,265	$ 130,088	$ 520,353	3,000	$ 173
1859	1,211,304	403,768	1,615,072	4,000	403
1860	1,671,410	557,133	2,228,543	4,400	506
1861	1,999,589	666,529	2,666,118	4,200	634
1862 1863	3,184,700	1,061,566	4,246,266	4,100 4,400	517 482
1864	2,801,888	933,962	3,735,850	4,400	849
1865	2,618,404	872,801	3,491,205	4,294	813
1866	1,996,580	665,526	2,662,106	2,982	893
1867	1,860,651	620,217	2,480,868	3,044	814
1868	1,779,729	593,243	2,372,972	2,390	992
1869	1,331,234	443,744	1,774,978	2,369	749
1870	1,002,717	334,239	1,336,956	2,348	569
1871	1,349,580	449,860	1,799,440	2,450	734
1872	1,208,229	402,743	1,610,972	2,400	671
1873	979,312	326,439	1,305,749	2,300	567
1874	1,383,464	461,154	1,844,618	2,868	643
1875	1,856,178	618,726	2,474,904	2,024	1,222
1876	1,339,986	446,662	1,786,648	2,282	783
1877	1,206,136	402,045	1,608,182	1,960	820
1878	1,062,670	1-5th 212,534	1,275,204	1,883	677
1879	1,075,049	" 215,009	1,290,058	2,124	607
1880	844,856	" 168,971	1,013,827	1,955	518
1881	872,281	" 174,456	1,046,737	1,898	551
1882	795,071	" 159,014	954,085	1,738	548
1883	661,877	" 132,375	794,252	1,965	404
1884	613,304	" 122,861	736,165	1,858	396
1885	594,782	" 118,956	713,738	2,902	246
1886	753,043	" 150,608	903,651	3,147	287
1887	578,924	" 115,785	693,709	2,342	296
			$5[illegible],983,226		

The statistics of the gold production of Nova Scotia in 1887 according to the report of Mr. Gilpin, Inspector of Mines of that province, will be found, by districts, in the following table A. Nova Scotia.

Tables B and C, compiled from the annual reports of the Inspector of Mines, give the production by districts as well as the yearly output for the whole of Nova Scotia since the beginning of the year 1862:—

GENERAL STATEMENT OF GOLD PRODUCTION IN NOVA SCOTIA FOR THE YEAR

TABLE A.

Districts.	No of mines.	Days labor.	Mills.	Steam power.	Water power.	Quartz, &c., crushed.	Yield per ton.			Total yield of gold.		
						tons.	oz.	dwt.	grs.	oz.	dwt.	grs.
Cariboo	3	7,832	1	1	0	2,689	0	13	20	1,861	9	22
Oldham	2	11,606	1	0	1	2,357	1	2	1	2,500	7	9
Renfrew	1	5,098	2	0	2	1 234	0	12	3	750	4	14
Sherbrooke	4	9,575	0	0	0	2,413	0	4	20	585	3	5
Stormont	3	2,964	1	1	0	645	0	6	20.7	293	16	22
Tangier	3	6,319	3	2	0	738	0	8	10	311	10	13
Uniacke	1	10,508	3	3	0	689	0	3	2	107	3	1
Salmon River	1	33,774	1	0	1	10,602	0	6	3	3,258	0	0
Brookfield	1	13,075	1	0	1	1,691	0	16	18	1,418	1	15
Whiteburn	2	7,599	3	3	0	1,094	2	3	3	2,305	12	13
Lake Catcha	2	12,116	2	2	0	601	4	18	15	2,959	4	0
Rawdon	3	31,560	1	1	0	5,302	0	13	5.6	3,507	13	8
Fifteen Mile Stream	1	4 920	1	1	0	829	0	9	15	398	5	0
Unproclaimed, &c	4	16,487	5	2	3	1,378	0	12	10	856	6	16
Totals	28	173,428	24	16	8	32,280	Av. 0-19-11			21,211	17	18

GOLD PRODUCTION OF THE DIFFERENT DISTRICTS IN NOVA SCOTIA FROM 1862 T

INCLUSIVE.

TABLE B.

District.	Total quantity of quartz crushed.	Total Yields.				Aver yield ton 2,000
		Quantity.			Value at $19.50 per oz.	
	Tons.	Oz.	dwt.	grs.		
Cariboo	23,647	17,606	0	4	$343,317	$14
Montague	13,828	28,417	0	10	554,133	40
Oldham	33,528	34,059	1	18	664,153	19
Renfrew	43,096	30,220	8	13	589,299	13
Sherbrooke	161,355	118,868	17	15	2,317,943	14
Stormont	16,355	18,656	6	17	363,797	22
Tangier	28,156	18,751	10	6	365,653	12
Uniacke	31,920	18,215	16	5	355,209	11
Waverly	88,953	53,158	18	4	1,036.598	11
Salmon River	10,604	3,258	0	0	63,531	5
Brookfield	1,691	1,418	1	15	27,652	16
Whiteburn	1,094	2,305	12	13	44,960	41
Lake Catcha	601	2,959	4	0	57,705	96
Rawdon	5,302	3,507	13	8	68,399	12
Wine Harbor	38,944	27,287	16	19	532,113	13
Darr's Hill	39,909	18,715	19	19	364,962	9
15 Mile Stream	1,917	958	11	23	18,693	9
Unproclaimed	44,171	35,262	10	15	687,620	15
Total	585,069	433,627	10	12	$8,455,736	$14

YEARLY PRODUCTION OF GOLD IN NOVA SCOTIA SINCE 1862.

TABLE C.

Year.	Tons of quartz crushed.	Total yields.				Average yield per ton of 2,000 lbs.
		Quantity.			Value @ $19.50.	
		Oz	Dwt.	Grs.		
1862	6,473	7,275	8	0	$141,871	$21.91
1863	17,000	13,971	13	17	272,448	16.02
1864	21,431	20,017	18	13	390,349	18.11
1865	24,421	25,454	3	22	496,357	20.32
1866	32,157	25,204	13	2	491,491	15.28
1867	31,384	27,310	18	11	532,563	16.96
1868	32,259	20,541	6	10	400,555	12.41
1869	35,144	17,868	0	19	348,427	9.91
1870	30,824	19,866	5	5	387,392	12.56
1871	30,787	19,229	7	4	374,972	12.17
1872	17,089	13,094	17	6	255,349	14.81
1873	17,708	11,852	7	18	231,122	13.05
1874	13,844	9,140	13	10	178,244	12.87
1875	14,810	11,211	14	19	218,629	14.89
1876	15,490	11,978	13	18	233,585	15.08
1877	17,369	16,882	6	1	329,205	19.01
1878	17,989	12,577	1	22	245,253	13.63
1879	15,936	13,760	8	21	268,328	16.83
1880	13,997	13,221	13	22	257,823	18.42
1881	16,556	10,756	13	2	209,755	12.66
1882	21,081	14,107	3	20	275,090	13.04
1883	25,954	15,446	9	23	301,207	11.60
1884	25,186	16,079	14	10	313,554	12.44
1885	28,890	22,203	12	20	432,971	14.98
1886	29,010	23,362	5	15	455,564	15.70
1887	32,280	21,211	17	18	413,631	12.81
Totals	585,069	433,627	10	12	$8,455,736	$14.45

Ontario.

Very little work was done in the Ontario gold mines in 1887; only small shipments of ore for test purposes were made from three or four of the mines. A new find was made late in the fall near Sudbury, in the township of Denison, from which very good specimens were obtained.

North West Territory and Yukon district.

A small amount of gold is obtained every year from the Saskatchewan river alluvions near Edmonton.

Dr. G. M. Dawson, from conversation with the miners, estimates the production of the Yukon district to have been about $60,000.

Quebec.

A little gold was obtained on the Mill river and the Gilbert river in Beauce county, and also a small quantity at Ditton, Compton county. Some promising exploratory work was done on the Cumberland and Des Plantes rivers.

In the report for last year the available statistics of the production of the Chaudière division in previous years was given. So far we have been unable to improve this imperfect record.

Exports.

The following table shows the exports of gold-bearing quartz, dust, nuggets, &c., as per Customs Department returns :—

Ontario	$ 6,650
Nova Scotia	321,379
British Columbia	592,300
Total	$920,329

Imports.

It is impossible to give the imports of gold coin and bullion, and of the manufactures of gold, as these articles are not entered separately in the returns of the Customs Department, but are grouped with the same articles of silver and also with copper coins.

GRAPHITE (Plumbago.)

Summary.

The total production of graphite in 1887 has been 300 tons, valued at $2,400 at the mine, which is situated near St. John, New Brunswick; another locality was being prospected near St. John, and there was also some prospecting work done for graphite in Waltham township, Pontiac county, Quebec. The mines near Buckingham, Ottawa county, Quebec, were not worked during the year.

Exports and Imports.

Exports of Graphite (Plumbago) from New Brunswick during the years 1885, 1886 and 1887.

Year.	Cwts.	Value.
1885	2,043	$ 917
1886	8,142	3,586
1887	6,294	3,017

The above table gives all the exports of graphite during the last three years, except 6 cwts. from Quebec in 1885.

In the following tables 1 and 2, will be found the imports of raw and manufactured plumbago, and of pencils and blacklead:—

IMPORTS OF RAW AND MANUFACTURED PLUMBAGO AND OF PENCILS FOR THE YEAR 1887.

TABLE 1.

PROVINCE.	Plumbago.	Manufactures of Plumbago.	Pencils, lead, in wood or otherwise.
Ontario	$1,473	$5,140	$33,458
Quebec	534	4,033	21,263
Nova Scotia	61	1,739	2,769
New Brunswick	....	657	3,028
Prince Edward Island	....	44	....
Manitoba	....	96	833
British Columbia	35	233	987
Totals	$2,103	11,94[illegible]	$62,338

IMPORTS OF BLACK LEAD.

TABLE 2

PROVINCE.	1886.	1887.
Ontario	$11,322	$7,001
Quebec	4,825	2,683
Nova Scotia	4,333	2,121
New Brunswick	4,049	3,559
Prince Edward Island	640	745
Manitoba	94	165
British Columbia	550	602
Totals	$25,813	$16,876

GYPSUM.

Crude

Taking the shipments from Nova Scotia as representing very
the total production of that province, the total quantity of crud
sum produced in 1887 was about 154,008 tons, valued in the rav
at the quarries at $157,277.

Comparison with 1886.

Compared with the preceding year the returns show a decre
the quantity of 7,992 tons, and in the value of $21,465.

Ground or Land plaster.

The total quantity of ground gypsum manufactured in the c
and used for land plaster, is calculated to have been about 12,00
Most of the Ontario production is milled and used as such;
contrary almost the whole of the quantity produced in Nova
is shipped in the crude state, and in New Brunswick most c
either shipped in the crude state or calcined into Plaster of Par

Calcined or Plaster of Paris.

From direct returns it was ascertained that 49,308 bbls. of Pla
Paris, made in the country from Canadian gypsum, were sold duri
year for $50,058 at the works; this does not include about 5,
6,000 bbls. made in Ontario, of which returns were not receiv
this was added, the statistics of this manufacture would proba
very nearly complete.

The Albert Manufacturing Co. of New Brunswick is by f
largest producer, and besides what is made in Ontario there a
small quantities made at Windsor, Nova Scotia, and at Quebec
Nova Scotia gypsum.

Production by provinces of crude gypsum.

The following table A gives the production of crude gypsu
each province, the value at the mines, the number of producer
the number of men employed:—

TABLE A

PROVINCE.	Tons.	Value.	No. of producers	No. of men employed
Nova Scotia....	116,346	$116,346	?	?
New Brunswick	29,102	29,216		179
Ontario	8,560	11,715	5	42
Totals......	154,008	$157,277	....	....

In Nova Scotia the different districts produced as follows, according to the report of the Inspector of Mines :— Nova Scotia.

District.	Tons.	Value.
Windsor (a).............	87,175	$86,595
Cheverie (a)............	23,870	17,840
Walton (a).............	545	382
Halifax (a)............	316	1,543
Arichat, C.B............	340	275
St. Ann's, C.B...........	4,100	4,000
Total............	116,346	$110,635

(a) Amount exported

The two districts of Albert and Victoria counties in New Brunswick show the following returns :— New Brunswick.

	Tons.	Value.
Albert County...............	27,805 (a)	$27,805
Victoria "	1,297	1,411
	29,102	$29,216

(a) A certain proportion of this was suitable for "terra alba" and sold as such, but the exact quantity could not be ascertained.

The producing district of Ontario is along the Grand River, principally in the county of Haldimand, but there are also some quarries in Brant county near Paris. The statistics are given in the above table A. Ontario.

The tables of the exports and imports of gypsum are given below and show how much greater the exports are than the imports :— Exports and imports.

EXPORTS OF CRUDE GYPSUM, BY PROVINCES IN 1886 AND 1887

TABLE 1.

Provinces.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario..............	350	$538	225	$337
Nova Scotia	118,985	114,116	112,557	106,910
New Brunswick.....	23,498	40,559	19,942	39,295
Total..........	142,833	$155,213	132,724	$146,542

EXPORTS OF GYPSUM (GROUND) (a) FROM NOVA SCOTIA AND NEW BRUNS-
WICK IN 1885, 1886 AND 1887.

TABLE 2

Provinces.	1885.	1886.	1887.
Nova Scotia.......	$ 294	$ 265	$ 662
New Brunswick....	15,404	24,670	13,291
Total........	$15,698	$24,935	$13,953

(a) Probably all plaster of Paris. This heading is the one in the Customs Dept. retu

There were no imports of crude gypsum into Canada during whereas during 1886, 1,557 tons valued at $2,492 were importe Ontario.

IMPORTS OF GROUND GYPSUM AND PLASTER OF PARIS DURING THE YEARS 1886 AND

TABLE 3

PROVINCES.	Ground Gypsum.				Plaster of Paris.			
	1886.		1887.		1886.		1887	
	Pounds.	Value	Pounds.	Value	Pounds.	Value.	Pounds.	V
Ontario.........	26,872	$129	5,506	$ 73	247,906	$1,338	243,350	[illegible]
Quebec.........	11,210	36	14,476	137	33,000	165	2,458	[illegible]
Nova Scotia	....	.....	......	.....	2,056	68	650	[illegible]
New Brunswick.	150,800	395	1,900	7	56,900	261	52,800	[illegible]
Manitoba.......	.....	.....	......	.....	242,700	1,297	146,300	[illegible]
British Columbia	....	.....	15,000	138	254,895	2,473	363,607	[illegible]
Totals	188,882	$560	36,882	$375	837,457	$5,602	809,165	[illegible]

IRON.

The total production of iron ore in Canada in 1887 was 76,330 tons, valued at the mines at $146,197. Iron ore.

This includes the quantities used in the blast furnaces at Drummondville which had not been obtained for the 1886 report, so that a comparison of the 1886 and 1887 figures is not possible.

By provinces, the iron ore statistics for 1887 are as follows:— Production by provinces.

PROVINCES.	Tons.	Value.	No. of men employed.	No. of Producers.	No. of Mines Producing.
Nova Scotia.....	43,532	$76,181	About 160	2	3
Ontario..........	16,598	36,218	129	2	7
Quebec	13,404	26,808	?	2	2
British Columbia.	2,796	6,990	20	1	1
Totals	76,330	$146,197		7	13

In Nova Scotia, according to the report of the Department of Mines, the East and West mines of Londonderry continued to be worked, and produced in 1887 43,360 tons and 80 tons of ankerite. There were also 172 tons of limonite mined at Bridgeville, Pictou county, and some prospecting work was done on the George river and on the East Bay deposits in the county of Cape Breton. Nova Scotia.

The following table compiled from the annual reports of the Department of Mines gives the yearly production since 1876:—

	Tons.
1876..................................	15,274
1877..................................	16,879
1878..................................	36,600
1879..................................	29,889
1880..................................	51,193
1881..................................	39,843
1882..................................	42,135
1883..................................	52,410
1884..................................	54,885
1885..................................	48,129
1886..................................	44,388
1887..................................	43,532

During the year 1887, iron mining in Ontario was almost entirely confined to the mines of the Kingston and Pembroke Iron Mining Ontario

Company, along the Kingston and Pembroke Railway line. Shipments were made from six of these mines, and amounted to 15,478 tons of a value at the mines of about $33,418. There were also about 1120 tons shipped from the district of Hastings; the other districts did not produce in 1887.

As shown in the tables of our 1886 statistical report, all the iron ore shipped from the provinces of Ontario and Quebec in the last 30 years amounted to about 600,000 tons only. In comparison we give the statistics published by the United States Survey, of the shipments of iron ore from the Vermillion Lake district of Minnesota, since 1884, when it first began to produce:—

	Long Tons.
1884 from August 1st to November 1st......	62,124
1885 " May to November................	225,484
1886 " " "	304,396
1887 (a) " "	390,467
	982,471 (b)

The Vermillion Lake district not being one of the most productive districts of the United States, the above comparative statement shows how little the iron mines of Ontario and Quebec have yet been developed, though rich deposits exist in those provinces in many places. Similar ores to those of Vermillion Lake and in the same geological conditions are known on the Canadian side of the boundary on Hunter's Island, and along Gun Flint Lake, and it is hoped they will prove equally rich and extensive.

Quebec. There were 13,404 tons of soft iron ores charged in the blast furnaces of Drummondville, and at the Radnor furnace, near Three Rivers, during the year. A good deal of work was also done at the Bristol mine, Pontiac county, where several thousand tons of iron ore were taken out, but no shipment was made, it being contemplated to previously roast the ore, and for this operation two Taylor Langdon gas kilns were erected.

Operations were suspended in March 1887 at the Texada Island mine and during the rest of the year it was not worked.

There were, nevertheless, 2,796 tons of ore shipped from that mine to Irondale, Washington Territory, and operations at the mine have now been resumed again.

(a) From the Marquette Mining Journal

(b) This is more than one million short tons.

The following table gives the exports for the last three years. Exports.
No iron ore is imported. Imports.

Province.	1885.		1886.		1887.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	15,426	$45,433	16,032	$51,175	12,244	$38,990
Quebec			2	10	38	119
New Brunswick	12	449				
British Columbia	190	425	3,130	7,225	1,410	3,525
Totals	15,628	$46,307	19,164	$58,410	13,692	$42,634

There were only four furnaces in blast during the year, one at Londonderry, N.S., two at Drummondville, Quebec, and the Radnor furnace, near Three Rivers. The first-mentioned was run with coke and a little raw coal, and the other three with charcoal. The statistics of their total production and consumption have been grouped in the following table A:— Pig Iron.

Pig Iron Production, and Consumption of Ore, Charcoal, Coke, Coal and Flux, in 1887.

Table A.

Number of furnaces in blast—4.

Production and Consumption.		Quantity.	Value at furnaces.
Pig Iron made		24,827 tons.	$366,192
Iron ore consumed		60,434 "	130,808
Fuel consumed	Charcoal	940,400 bush.	48,593
	Coke	30,248 tons.	89,123
	Raw coal	3,333 "	5,677
Flux consumed		17,171 "	17,500

About 250 men were employed.

No pig iron is exported.

The imports for the last three years with the values are given by provinces in the following table 1 which shows, by comparison with Exports and Imports.

the above table, that the importation of pig iron in 1887 was about twice the production in the country, and also that the pig iron manufactured in Canada is of a superior quality and commands a higher price.

IMPORTS OF PIG IRON BY PROVINCES IN 1885, 1886 AND 1887.

TABLE 1.

Province.	1885.		1886.		1887.		
	Tons.	Value.	Tons.	Value.	Tons	Value.	Duty.
Ontario	17,149	$248,430	20,499	$298,299	19,451	$298,083	$ 61,291
Quebec	21,306	243,997	22,477	233,183	25,317	263,098	77,903
Nova Scotia	1,632	19,044	860	13,927	1,197	16,171	3,613
New Brunswick	2 684	40,513	2,824	51,352	1,729	36,771	5,302
Prince Edward Island	67	767	78	814	....	....	....
British Columbia	1,021	13,662	631	8,819	557	5,981	1,211
Totals	43,759	$566,413	47,380	$604,384	48,251	$620,104	$149,330

As exhibited in the above tables, the total quantity of pig iron consumed (imported and manufactured) in 1887 was about 73,000 tons, having a value of about one million dollars; this was nearly all used as cast iron in the foundries, as the Londonderry Iron Works and the Nova Scotia Steel Works—which alone made iron or steel from pig iron —used only 3,799 tons of pig iron for that purpose. It must be well understood, however, that the above stated consumption of pig iron does not represent at all the quantity of pig iron that might be annually manufactured for the market of Canada, as besides the pig iron that is imported there is also imported a great quantity of manufactures of cast iron, as well as a very great weight of iron and steel made from pig iron in the iron and steel works of foreign countries. We have calculated from the tables given in the 1886 annual report, pages 42, 43 and 44, and from tables Nos. 2 to 9, inclusive, given below, that the imports of all articles of iron and steel, in the price of which the principal item is the weight of the metal, (not including cutlery, edge-tools, machinery of all sorts, engines and other hardware and manufactures) amounted in 1886 and 1887, respectively, to about 287,798 tons, and 235,792 tons made up as follows:—

1886.		1887.	
Iron	110,428 tons.	Iron	90,850 tons.
Steel	18,723 "	Steel	16,630 "
Castings and Forgings	8,544 "	Iron and Steel	48,636 "
Railroad (iron and steel)	142,761 "	Castings and Forgings	7,076 "
Hardware and mfrs	7,342 "	Railroad (iron and steel)	72,600 "
Total	287,798 tons.	Total	235,792 tons

The equivalents in pig iron of these quantities of iron and steel, which are only a part of what was entered for consumption in 1886 and 1887, would be respectively about 345,000 tons and 283,000 tons. If to this is added the amount of pig iron consumed as such, it will be seen that—excluding all the iron and steel entering into such highly manufactured articles as cutlery, surgical instruments, edge tools, machinery of all kinds, engines and many other hardwares and manufactures—there was a total consumption equivalent in pig iron, in 1886 and 1887 respectively, to about 415,000 tons and 356,000 tons. If made in the country, this quantity of pig iron would represent to our makers at actual prices a value of about $5,000,000; it would necessitate a yearly supply from Canadian iron mines of 1,000,000 tons of ore, and, before this ore could be melted into pig iron and further made into the different merchantable articles of iron and steel which are now imported, it would also require about 3,000,000 tons of coal.

The above statistical statement of our needs in iron will be a guide as to what can be done towards developing iron and steel industries in Canada; it also gives an insight into the splendid future of these industries; let us see now what is actually being done. Iron and Steel.

Returns where received from the Nova Scotia Steel Co., the Nova Scotia Forge Co., the Londonderry Iron Works and from six rolling mills. We regret very much that notwithstanding repeated efforts, returns could not be obtained from Messrs. J. A. & W. A. Chesley of St. John, N.B., The Montreal Rolling Mills Co., Messrs. Pillow, Hersey & Co., Messrs. Peck, Benny & Co., and the Metropolitan Rolling Mills of Montreal.

As far as received, the returns show :—

Description of articles made or consumed.	Quantity.	Value.
	Tons.	
Iron, all sorts, made......	31,537	$1,087,728
Puddled iron bars consumed	2,312	58,700
Scrap iron and all other, consumed.......	36,448	579,497
Steel, all sorts, made.......	7,326	331,199
Steel consumed (almost all scrap steel).......	8,407	149,177
Pig iron consumed in the manufacture of iron and steel.	3,799	56,990
Fuel consumed in the manufacture of iron and steel..	58,112	146.986
Men employed—about 850		

This statement is estimated to represent about $\frac{2}{3}$ of the total produ tion of iron and about $\frac{3}{4}$ of the total production of steel. If the man facturers named above had not met our repeated requests for retur with a spirit of suspicion or indifference these statistics could ha been made more complete ; fortunately, only a minority of the ir makers adopted the course, and it is hoped that even this minority w in the future be convinced of the necessity and advantages of havi complete returns.

Exports and Imports.

The following tables give the exports and imports of iron and ste goods :—

EXPORTS OF IRON AND STEEL GOODS MANUFACTURED IN CANADA. YEAR 1887.

TABLE 1.

PROVINCE.	Iron, Scrap.	Iron Castings.	Iron, Stoves.	Iron, all other, and Hardware.	Steel, and Manufactures of.	Total.
Ontario	$62,108	$10,240	$796	$17,558	$5,228	$95,930
Quebec...........	7,148	2,851	684	52,201	19,307	83,191
Nova Scotia	2,005	1,880	750	18,601	41,030	64,370
New Brunswick....	114	72	....	6,847	434	7,467
Prince Edward Is'd.	....	40	....	7	14	61
Manitoba.........	....	1	143	293	859	1,296
Totals	$71,375	$15,084	$2,383	$95,507	$66,872	$251,221

IMPORTS OF IRON IN SLABS, BLOOMS, LOOPS, PUDDLED BARS, ETC., FOR 1886 AND 1887.

TABLE 2

Province.	1886.		1887.		
	Cwts.	Value.	Cwts.	Value.	Duty.
Ontario	291	$ 812	11,332	$ 8,995	$ 899
Quebec	354,130	289,702	348.557	285,233	50,520
Nova Scotia	438	369	1,116	8,552	855
New Brunswick	5,493	4,583	6,548	3,948	395
British Columbia	....	8	....	....	....
Totals	360,352	$295,474	367,553	$306,728	$52,669

IMPORTS OF SCRAP IRON AND SCRAP STEEL FOR 1886 AND 1887.

TABLE 3.

Province.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	5,616	$ 6,788	18,776	$81,091
Quebec	137,985	87,360	252,042	161,167
Nova Scotia	67,803	54,673	84,349	43,904
New Brunswick	36,440	23,115	54,718	40,169
British Columbia	40	15	440	262
Totals	247,884	$171,951	411,324	$326,59[illegible]

This Table 3 forcibly exhibits the immediate good results of the new protective tariff which, having very wisely been made to bear more heavily on the manufactured products, has at once given rise to an increase of 66 per cent. in the imports of the raw material for our iron mills, proving a very marked greater activity in those mills since last May.

IMPORTS OF IRON.

IMPORTS OF FERRO-MANGANESE, FERRO-SILICON, SPIEGEL, STEEL BLOOM ENDS AND ENDS OF STEEL RAILS FOR THE YEAR 1887.

TABLE 4.

PROVINCE.	Tons.	Value.	Duty.
Quebec	1,121	$16,772	$2,242
Nova Scotia	274	3,531	549
New Brunswick	277	4,385	553
Totals.............	1,672	$24,688	$3,344

In the following tables the headings of the articles have epitomized from the classification used by the Customs Depart this was rendered necessary by the change in the tariff on th May, 1887.

TABLE 5.

ARTICLES.		Quantity.	Value.
Bar iron, rolled or hammered.......................	cwt.	534,972	$654,918
Boiler or other plate iron, inch nail plate............	"	83,787	182,254
Tacks, brads and sprigs..............................			6,552
Band and hoop iron..................................	"	82,624	118,028
Iron in slabs, blooms, loops, puddle bars, &c.........	"	307,563	306,738
Iron bridges and structural iron work	lbs.	3,212,220	104,214
Nails, spikes and sheathing nails compressed........	"	24,378	3,161
Nails and spikes	"	857,275	14,521
" " cut	"	264,235	9,594
" " incl. R. R. spikes.........................	"	133,358	4,588
Nail and spike rods	cwt.	2,193	4,744
Iron, N. O. P. F	"	2,427	2,590
Ornamental iron work			308
Rolled round wire rods in coils	"	187	296
Swedish rolled iron nail rods	"	22,710	33,320
Tubing of every description........................			436,162
Wire work, other....................................			54,570
Manufactures of iron, N.O P F.			8,845
Hoop iron for tubular rivets	"	73	805
Total....			$1,8[illegible]1,257

IMPORTS OF STEEL.

TABLE 6.

Articles.		Quantity.	Value.	Duty.
Wire, spring steel, coppered	cwt.	1,872	$6,270	$1,150
Locomotive tires	"	9,967	40,572	(a) 1,836
Steel Ingots, blooms, slabs, billets, bars, sheets, &c.	"	272,920	516,471	117,237
Axes			11,823	4,313
Saws			63,113	18,945
Steel for manufacture of files	"	1,348	5,899	Free
" " skates	"	1,636	5,506	"
" " saws and straw cutters	"	8,216	67,291	"
" " mower and reaper knives	"	2,002	8,498	"
" " knobs, locks and cutlery	"	4,708	8,547	"
" " corsets, shoes, & clock springs	"	3,097	11,407	"
" " spades and shovels	"	2,387	9,023	"
Homo spring steel, for mattrasses	lbs.	569,523	20,397	"
Total			$773,821	$143,481

(a) This duty was collected previous to 13th May, 1887, when this article was placed on the free list.

IMPORTS OF IRON AND STEEL.

TABLE 7.

Articles.		Quantity.	Value.	Duty
Axles and springs of iron or steel	cwt.	14,460	$ 29,742	$ 10,275
Chains over 9-16 inch. diam	"	16,752	32,471	2,138
Chain cables, all other to 13th May, 1887	"	9,966	30,136	6,649
Iron or steel bolts, nuts, rivets, etc.	lbs.	748,768	45,286	17,689
Rolled iron or steel angles, beams, girders, and all structural shapes	cwt.	154,251	222,210	30,228
Screws, iron and steel "Wood screws"	"		25,750	6,710
Sheet iron	"	312,601	615,074	79,026
Wire fencing, barbed, of iron or steel	lbs.	65,310	2,337	816
" " Buckthorn, etc., iron or steel	"	44,934	1,458	631
" of iron or steel, 15 guage and coarser, N.E.S.	cwt.	91,973	194,555	42,265
" rope of iron or steel, N.E.S	"	2,323	30,055	7,510
Mfrs. of iron or steel, N.E.S			286,543	82,386
Iron or steel rolled round wire rods	"	57,901	74,482	Free
Iron or steel beams, etc., for composite ships	"	7,128	14,420	"
Wire iron or steel, 16 gauge or smaller	lbs.	1,622,944	89,286	"
Wire rigging for ships	cwt.	2,849	11,033	"
Total			$1,704,778	$287,563

IMPORTS OF CASTINGS AND FORGINGS.

TABLE 8.

Articles.		Quantity.	Value.	Duty.
Castings of every description and forgings			$230,344	$ 65,423
Cast iron pipe of every description			166,573	81,949
Malleable iron castings and steel castings			67,473	16,493
Anvils, to 13th May, 1887	cwt	553	3,299	988
Stoves			15,914	4,426
Anchors	"	2,863	9,715	Free
Total			$503,318	$169,279

IMPORTS OF RAILROAD IRON AND STEEL.

TABLE 9.

ARTICLES.		Quantity.	Value
Car Wheels	cwt.	7,666	$ 25,278
Railway bars, iron or steel	"	13,485	21,948
" fish plates	"	47,050	62,469
Steel rails	"	[illegible]	[illegible]
" " for C. P. Ry.	lbs.	48,225,610	[illegible]
" " " E. & N. Ry.	"	10,524	[illegible]
Totals	tons	72,000	$1,580,316

SUMMARY TABLE OF THE IMPORTS OF PIG IRON, IRON AND STEEL, FOR THE Y
(ARTICLES NOT HIGHLY MANUFACTURED)

TABLE 10.

ARTICLES.	Value.	Duty.
Pig iron	$620,104	$149,380
Ferro manganese, etc.	24,688	3,344
Scrap iron and steel	326,593	33,694
Blooms, etc.	306,728	52,669
"Iron"	1,891,257	491,097
"Steel"	773,821	143,381
"Iron and steel"	1,704,778	287,563
Castings and forgings	503,318	169,279
Railroad iron and steel	1,580,316	30,238
Totals	$7,731,603	$1,360,555

IMPORTS OF IRON AND STEEL HIGHLY MANUFACTURED ARTICLES NOT INCLUD
PREVIOUS TABLES, FOR FISCAL YEARS 1886 AND 1887.

TABLE 11.

COUNTRIES FROM WHENCE IMPORTED.	1886.		1887
	Value.	Duty.	Value.
Great Britain	$688,028	$82,290	[illegible]
United States	2,500,946	692,764	2,369,321
France	6,469	[illegible]	8,436
Germany	41,137	10,847	89,094
Belgium	14,156	2,950	49,509
Switzerland	1,369	4[illegible]8	2,029
Other countries	1,514	398	947
Totals	$3,253,649	$891,279	$3,408,926

Assuming that the imports shown in the above table 11 for the fiscal years are very nearly the same on the average as those for the calendar years, we see that the total imports of all pig iron, iron and steel articles and goods, were in 1887 of a declared value of a little more than $11,000,000, and that the duty paid was a trifle over $2,300,000.

LITHOGRAPHIC STONE.

It is very much to be regretted that the Canadian lithographic stone quarries have not been worked in 1887, and that nothing further has been done to develop them. It is a well-known fact that the Bavarian quarries do not produce now a sufficient quantity of the best quality stones for the requirements of the American market, and it should lead to the development of our own supply. The lithographic stones of the townships of Madoc and Marmora, and of the counties of Peterboro and Bruce have been examined and practically tested by lithographers, and in several cases, pronounced to be of good quality; they have also obtained medals at various exhibitions. They were obtained from the surface in small quarries and possibly, when the quarries are more developed, better stones free from "specks" of quartz or calcite will be available in large slabs.

The following table shows our imports for the last three years Imports.

IMPORTS OF LITHOGRAPHIC STONES.

TABLE 1.

PROVINCE.	1885.	1886.	1887.
Ontario	$1,033	$4,037	$3,756
Quebec	926	1,715	2,613
New Brunswick.......	2	8	....
British Columbia......	27	2	....
Total.........	$1,988	$5,762	$6,369

MANGANESE.

Total production and comparison with 1886.

The total production of Manganese ore in 1887 was 1,24 valued at the mines at $43,658.

This compared with 1886 shows a decrease in the quantit tons, but an increase in value of $2,159, indicating that a high ore was obtained.

Production by provinces.

Nova Scotia and New Brunswick are the only provinces Dominion where manganese mines are in active operation, production of each of these provinces was as follows:—

	Tons.	Value at mines.
New Brunswick	939½	$22,398
Nova Scotia (a)	306	21,260
Total	1,245½	$43,658

(a) The 385 tons from Cornwallis of a value of $2,233 is classed as an ochre

New Brunswick.

In New Brunswick, the Markham mine which has now bee ing continuously for 25 years, provides the greater part production. Twenty men were employed at the mines and the works; two classes of ore were produced:—the "metal worth about $15.00 a ton at the mine and shipped to England, "chemical" ore worth from $50.00 to $60.00 and shipped to these two names sufficiently indicate the uses of these ores

Two other mines in King's county produced also small q in 1887, and development work was being proceeded with o tensive bog manganese deposit at Hillsboro', Albert county.

Nova Scotia.

The following table, taken from the report of the Depart Mines, exhibits the production by districts in Nova Scotia:—

	Tons.	Value.
Onslow mine	40	$3,800
Pembroke	25	1,750
Tenny Cape	235	16,450
Cornwallis (a)	385	2,233
Cheverie	5	200
Maitland	1	60
Total	691	$[illegible]3,493

(a) Classed as ochre in the above table of the summary production.

Statistics of the production in Nova Scotia, since 1877, acco the annual reports of the Department of Mines, may be foun report for 1886.

The tables of exports were also given since 1868 in the last report; a table of the exports for the last three years only is now given, and one of the imports of oxide of manganese. Exports and Imports.

EXPORTS OF MANGANESE ORE.

TABLE 1.

Year.	Nova Scotia.		New Brunswick.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1885......	77	$5,054	1,607	$29,595	1,684	$34,649
1886......	441(a)	30,854	1,377	27,484	1,818	58,338
1887 (b)...	578(a)	14,240	837	20,562	1,415	34,802

(a) A certain amount from Cornwallis included in these quantities more properly comes under the heading mineral pigment.

(b) 7-10ths of a ton valued at $53.00 exported from Quebec this year.

IMPORTS OF OXIDE OF MANGANESE

TABLE 2.

Provinces.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario................	16,464	$ 824	18,733	$903
Quebec..................	29,413	1,530	48,977	2,171
Nova Scotia............	1,075	75	1,173	79
Manitoba...............	609	26	....	. . ....
British Columbia........	....	....	1,010	16
Total..............	47,561	$2,455	69,893	$3,169

MICA.

Total production.

The returns received show 22,083 lbs. of cut mica marketed in valued at the works at $29,816 ; the average price therefore is The quantity mined and cut during the year was $39,500 lbs., and was also marketed 18 tons of ground mica sold for $700 ; these re are believed to include the whole of the production in Canada ; represent the production of four different mines ; three in the vince of Ontario and one in Quebec, employing altogether abo men.

In comparison with 1886, there is an increase of 1,722 lbs., i amount of cut mica marketed with an increase of price of this indicates a decrease, in the average price, of 7 cts. a pound d the fact that a market was found for a second class quality mica one of the mines.

Exports and imports.

There were 1000 lbs. of cut mica exported to the United States Kingston during the year, according to the returns of the Cus Department.

We regret being unable to give the imports, there being no sp entry for mica in the books of the Customs Department.

MINERAL PIGMENTS.

In the following table is given the returned production of mineral pigments :—

Product.	Tons.	Value.	Prov. where produced
Baryta............	400	$3,400	N.S.
Ochre............	385	2,233	N.S.
Mineral Paint.......	100	1,500	Ont.
Whiting...........	75	600	Ont.
Total.........	960	$6,733	

The baryta was all produced in Nova Scotia, no shipments ha been made from McKellar's Island, Lake Superior, in 1887.

Imports.

Tables of the imports of these products and other mineral pigm are given below :—

IMPORTS OF UNMANUFACTURED BARYTA.

TABLE 1.

Province.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	45	$291	2	$ 24
Quebec	127	80	....	....
Nova Scotia	238	54	....	....
New Brunswick	6	47	200	252
Total	416	$472	202	$276

IMPORTS OF PAINTS.

TABLE 2.

VARIETY.	Lbs.	Value.
Fire-proof paint, dry	216,174	$3,112
Paint, ground in oil or any other liquid	......	112,807
White and red lead and orange mineral, dry	6,876,910	286,589
White lead in pulp, not mixed with oil	... ..	276
Ochres, dry, ground or unground, washed or unwashed, not calcined	1,676,434	16,371
Zinc, dry white	.....	28,227
Other paints and colors, N. O. P. F.	......	87,069

IMPORTS OF WHITING.

TABLE 3.

PROVINCE.	1886.		1887	
	Cwts.	Value.	Cwts.	Value.
Ontario	10,272	$3,577	8,868	$3,325
Quebec	24,839	8,698	52,949	13,659
Nova Scotia	8,654	1,823	2,689	1,027
New Brunswick	2,773	1,166	2,494	1,038
Prince Edward Island	100	61	464	190
British Columbia	739	857	274	121
Total	47,386	$16,182	67,738	$19,360

IMPORTS OF CHALK.

TABLE 4.

Province.	1885.	1886.	1887.
Ontario	$4,862	$3,053	$2,48
Quebec	1,323	1,657	1,86
Nova Scotia	230	167	21
New Brunswick	66	191	44
Prince Edward Island	23	20	3
Manitoba	71	208	16
British Columbia	13	28	2
Total	$6,607	$5,334	$5 2

IMPORTS OF LITHARGE.

TABLE 5.

Province.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value
Ontario	3,843	$13,001	6,354	$21,03
Quebec	1,891	6,289	2,353	7,44
Nova Scotia	2	8	2	[illegible]
New Brunswick	13	85	11	7
Manitoba	10	41	33	12
British Columbia	6	35	3	2
Total	5,765	$19,459	8,756	$28,705

MISCELLANEOUS.

Returns of a small production of certain miscellaneous m
were received and are given in the following table:—

Product.	Quantity.	Value.	Province whe produced
Chromic Iron	38 tons.	$ 570	Que
Lead.. { Fine contained in ore. }	204,800 lbs.	9,216	B.C.
Moulding sand	160 tons.	800	N.S
Platinum	1,400 ozs.	5,600	B.C.
Soapstone	100 tons.	800	Que.

The lead ore was obtained at the mine of The Selkirk Mining and Smelting Co., in the Illecillewaet district, B.C.; preparatory work was also continued at the Lake Temiscamingue mine, Quebec. Lead.

The platinum was derived from the placer mines of Granite Creek, Similkameen division, B.C., and was sold in Portland, Oregon. In the report of the Minister of Mines of British Columbia, the total production of platinum of the Similkameen division is estimated at 2,000 ozs., by Mr. Tunstall, the gold commissioner of that division. Platinum.

As shown in the report for 1886, the exports of lead ore from Canada were always very small and of no importance; it is still so in 1887. Exports and Imports.

The imports of lead and platinum are tabulated below, as well as the imports of zinc, tin and mercury, of which there was no production. Zinc, Tin and Mercury.

The imports of glass and manufactures of, are also given in table 7. The exports of glass and glassware amounted only to $1,030. Glass.

IMPORTS OF LEAD.

TABLE 1

ARTICLES	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Lead, old, scrap and pig	68,794	$142,667	69,866	$182,059
" bars, blocks and sheets.	10,488	32,450	20,048	58,283
" pipe	613	2,016	1,783	6,322
" shot	2,907	9,661	1,260	4,204
" mfrs. of, N.O.P.F.......	......	9,884	......	6,772
Total...........	......	$196,678	......	$257,640

IMPORTS OF PLATINUM WIRE.

TABLE 2.

PROVINCE.	Ozs.	Value.
Ontario................	207	$1,555
Quebec	4	68
New Brunswick (a).......	64	13
Total...........	275	$1,636

(a) Returns for New Brunswick incorrect.

IMPORTS OF ZINC IN BLOCKS, PIGS AND SHEETS.

TABLE 3.

Provinces.	1886.		1887.	
	Cwt.	Value.	Cwt.	Val
Ontario	5,307	$19,667	5,981	[illegible]
Quebec	15,457	56,905	10,731	38,
Nova Scotia	1,456	5,973	2,221	6,
New Brunswick	1,457	7,387	2,022	7,
Prince Edward Island	102	371	154	
Manitoba	50	199	825	2,
British Columbia	209	785	67	
Totals	24,036	$91,287	22,001	$83,

IMPORTS OF TIN.

TABLE 4.

Provinces.	1886.				1887.		
	Blocks, pigs and bars.		Tin-foil.		Blocks, pigs and bars.		Tin-f
	Cwt.	Value.	Pounds	Value.	Cwt.	Value.	Pounds
Ontario	4,017	$73,661	30,929	$ 5,480	4,858	$78,908	49,232
Quebec	7,822	104,717	57,602	11,226	3,441	63,502	65,760
Nova Scotia	2,423	39,937	1,063	255	984	21,260	4,683
New Brunswick	587	11,333	184	45	1,171	12,744	350
Prince Edward Island	451	10,047	......	......	182	4,114	10
Manitoba	42	939	655	290	......	......	408
British Columbia	1,639	36,301	50	14	847	21,092	37
Totals	16,981	$276,935	90,503	$17,250	11,483	$221,680	120,480
Total Tin-foil.—Cwts.	905	17,250	......	......	1,204	23,145	...
Total Tin	17,886	$294,185	......	......	12,687	$244,825	...

IMPORTS OF TIN PLATES AND SHEETS

TABLE 5.

PROVINCES.	1886.		1887.	
	Cwt.	Value.	Cwt.	Value.
Ontario	67,200	$248,899	81,225	$245,100
Quebec	75,302	251,240	80,375	286,670
Nova Scotia	29,346	96,101	11,764	74,879
New Brunswick	7,769	29,316	5,485	21,076
Prince Edward Island	9,106	27,006	2,030	6,731
Manitoba	1,415	4,380	1,714	5,246
British Columbia	35,933	145,413	16,156	64,210
Totals	226,071	$802 355	198,749	$693,912

IMPORTS OF MERCURY

TABLE 6.

PROVINCES.	1886.		1887	
	Pounds.	Value.	Pounds.	Value.
Ontario	8,742	$5,020	25,062	$12,778
Quebec	1,422	684	2,307	1,210
Nova Scotia	1,648	1,052	1,851	1,222
New Brunswick	20	11	......	......
Manitoba	80	44	3	2
British Columbia	4,210	1,881	1,866	1,174
Totals	16,122	$8,792	31,089	$16,386

IMPORTS OF GLASS.

TABLE 7.

Description.	Quantity. Square feet.	Va
Carboys, demijohns, bottles and decanters, flasks and phials, telegraph and lightning rod insulators, jars and glass balls, and cut, pressed, or moulded table ware	....	$25
Carboys and demijohns, bottles and decanters flasks and phials of less capacity than eight ounces	....	4
Flasks and phials of eight ounces capacity and over, telegraph and lightning rod insulators jars and glass balls, and cut, pressed, and moulded table ware	....	9
Lamp and gas-light shades, lamps and lamp-chimneys, side-lights and head-lights, globes for lanterns, lamps, and gas-lights	....	21
Ornamental, figured, and enamelled stained glass	....	
Stained, tinted, painted, and vitrified glass and stained glass windows, figured enamelled, and obscured white glass	....	1
Common and colourless window glass	14,750,961	30
Coloured glass, not figured, painted, enamelled, or engraved	36,403	
Photographic dry plates	17,416	
Plate glass, not coloured, in panes not over 30 sq. ft.	169,148	5
" " " over 30 & not over 70 "	157,363	5
" " " over 70 sq. ft.	206,808	6
Silvered plate glass	....	[illegible]
Porcelain shades, imitation	....	1
All other mfrs. of glass, N. O. P. F.	....	8
Total		$1,23

PETROLEUM.

Summary of the production. Inspection returns.

The Petroleum Inspection returns as entered in the books of the Inland Revenue Department show that the number of packages of Canadian refined oil (refined petroleum and naphtha) inspected during the year 1887 were:—

(1) 221,684 packages at 10c. inspection fee.
(2) 619 " 5c. "
(3) 35,134 " 2½c. "

Refined oil.

Rating the different packages, (1) (2) and (3) as containing respectively 35, 10, and 4 imperial gallons, we have a total of Canadian refined oils during the year of 7,905,666 imperial gallons, or 225,876 barrels of 35 imperial gallons. This at the yield of 100 crude oil for 38 refined, corresponds to 20,804,384 imperial gallons, or to 594,411 barrels of 35 imperial gallons, of crude oil. Taking the average price for the year on the Petrolea Oil Exchange of 78c. per barrel of crude oil, the value would be $463,641.

Crude oil.

Comparison with 1886.

Compared with our Inspection returns of 1886, which were made up as above from the number of packages inspected entered in the books of the Inland Revenue Department, the above statement shows an increase in 1887 of 107,970 barrels, or of 22 per cent in the quantity, but of only $25,844 in the total value.

In the following table will be found the quantities of Canadian oil inspected, and the corresponding equivalents in crude oil since 1881, obtained for each year by a similar calculation based on the number of packages entered in the Inland Revenue Department books.

CANADIAN PETROLEUM AND NAPHTHA INSPECTED AND CORRESPONDING QUANTITIES OF CRUDE OIL.

TABLE A.

Year.	Refined Oils Inspected.	Crude Equivalent Calculated.	Ratio of Crude to Refined.
1881	5,380,081	10,760,162	100 : 50
1882	5,111,893	11,359,762	100 : 45
1883	6,204,544	13,787,875	100 : 45
1884	6,730,068	16,825,170	100 : 40
1885	5,853,290	14,633,225	100 : 40
1886	6,469,667	17,025,439	100 : 38
1887	7,905,666	20,804,384	100 : 38

Direct returns. Summary of the production.

Direct returns were kindly sent from 13 refineries, 9 of w situated in Petrolea, 2 in London, 1 in Hamilton, and 1 in Sar believed that the whole of the refining operations in Canada covered by these returns, and that there were only two oth refiners, one in Petrolea and one in Montreal, both of whom of business during the year, so that it has been impossible to the statistics of their production and consumption. The three companies of Petrolea have also very willingly forwarded t statistics of their operations.

These returns are summarised in the following tables:—

MAIN PRODUCTION of CANADIAN REFINERIES IN 1887.

TABLE B.

Products.	Imp. gals.	Value at refinery.
Illuminating oils	10,387,825	$991,29
Benzine and Naphtha	344,570	31,447
Black and Paraffine oils, (including fuel, gas, and lubricating oils	6,793,461	240,851
Paraffine Wax	lbs. 400,036	24,521
Total value		$1,288,10

MAIN CONSUMPTION OF THE CANADIAN REFINERIES IN 1887

TABLE C.

Crude Petroleum	26,737,668 Imp. gals
Sulphuric Acid (a)	3,215,410 lbs.
Soda (a)	331,898 "
Litharge (a)	496,163 "
Sulphur (a)	98,616 "

(a) The quantities consumed by the Sarnia refinery could not be ascertained, but they were small and do not much materially affect the result.

The above tables B and C exhibit:—

1st. That the percentage of the different oils per 100 cru leum was as follows:—

Illuminating Oils	38.00
Benzine and Naphtha	1.30
Black and Paraffine Oils (including fuel, gas and lubricating oils, and paraffine wax)	25.70
Heavy tar and Residuum, Coke and waste (not returned.)	35.00
	100.00

2nd. That, there were 763,933 bbls. of 35 imp. gals. of crude oil consumed during the year in the manufacture of illuminating oils.

3rd. That, besides and above the 7,905,666 imp. gals. of refined petroleum and naphtha inspected during the year, there were also 2,836,729 imp. gals. produced in the refineries and not yet inspected at the close of the year. As this would indicate a stock, carried over from year to year in the country, of some 5,000,000 gals. of refined oils which is much more than the real stock carried, it shows that the calculations based on the number of packages of refined oils inspected give an incorrect and too low a result. The figures in table A above are consequently believed to be about one third too low. It is to be regretted that the Inland Revenue Department does not keep a record of the number of gallons inspected instead of the number of packages.

The returns of the tanking companies give the following results:—

CRUDE OIL.

Stocks on 1st January, 1887	388,192 $\frac{3}{7}$ bbls.
Quantity of Oil delivered to tanking Co's. from wells, in 1887	414,273 $\frac{3}{4}$ "
Quantity of Oil delivered by tanking Co's, in 1887	584,672 $\frac{1}{4}$ "
Stocks on 1st January, 1888	217,793 $\frac{4}{5}$

Compared with the direct returns of the refiners, the above statement shows that the refiners themselves must have received directly from the wells, about 180,000 bbls. of crude petroleum during the year, making the total production from the wells in 1887 to be:—

414,273 $\frac{3}{4}$ bbls.	received by tanking Co's.
180,000 "	" refiners.
Total..594,273 $\frac{3}{4}$ bbls.	

This total production from the wells in 1887 of 594,274 bbls., added to the balance in the stocks on 1st January 1887 and on 1st January 1888, which was one of 170,399 bbls., gives 764,673 bbls. as the quantity of oil available for consumption during the year, and proves that the direct returns from the refiners of their crude consumption are correct. The returns of the tanking companies exhibit also a decrease in the stocks at the end of 1887 of nearly 44 per cent.

Petrolia Oil Exchange business in 1887.

We are also indebted to James Kerr, Esq., Secretary of the P Oil Exchange, for the following tables of the business during th 1887 on that exchange, and of the average closing prices per for the years 1885, 1886 and 1887:—

PETROLIA OIL EXCHANGE, CRUDE PETROLEUM BUSINESS FOR THE YEAR 188

Month.	Opening price.	Highest price.	Lowest price.	Closing price.	Average closing price	Average price.	Total Barre unp e
January	92	92	80	83¼	84.78	84.71	4
February	83½	84½	79¾	79¾	81.63	82.38	3
March	79½	79½	75	77¼	76.72	78.26	4
April	77	77	74	74½	75.04	75.61	3
May	74	74	70	67½	69.29	75.89	3
June	67½	69½	66	68½	67.26	73.42	3
July	68½	68½	66½	66½	67.50	72.34	1
August	66½	83½	66½	82½	71.36	78.55	3
September	83	84	78½	79	81.03	83.78	3
October	79¾	79¾	75	75¾	77.12	77⅞	2
November	75⅞	75½	76	73¾	72.21	72½	2
December	73¾	80	72½	76	76.30	77¾	4
Year 1887	92	92	66	76	78.02	78	40
Puts and Calls							4
							45

"The above is a resumé of sales and resales of crude oil war certificates on the Petrolia Oil Exchange during the year 1887, dicates the market price of Petroleum Oil (crude) as stated in house. The further charge of 3 cents per barrel is made when t is delivered for pipeage to refiners in each case."

AVERAGE CLOSING PRICE OF CRUDE OIL ON PETROLEA OIL EXCHANGE.

Month.	1885	1886	1887
January	75¼	88¼	84¾
February	86¾	88¼	81¾
March	83¾	89¼	76¾
April	80¼	90	75
May	78	90	69¼
June	79	90	67¼
July	83	80	67½
August	91¼	75½	71¼
September	89½	75	81
October	79½	84¼	77¼
November	79¼	93¾	72¼
December	83½	97	76¼
Year	82¼	86¾	78

Tables of the exports of Canadian petroleum since the beginning of the operations in the Ontario oil fields in 1861 are given in the report for 1886, and show how fluctuating the exportations always were: varying from 9,000,000 to nothing; in 1887 they were as follows:— Exports.

EXPORTS OF CANADIAN PETROLEUM IN 1887.

TABLE 1.

PROVINCES.	Gallons.	Value.
Ontario	472,362	$13,616
Quebec	916	147
Nova Scotia	281	68
Totals	473,559	$13,831

Imports.

The following Table 2 is from the inspection returns of the Revenue Department, and Table 3 is from the returns of the Department. Table 4 shows the imports of crude oil, calcul taking the difference between the totals of Tables 2 and 3.

REFINED PETROLEUM AND NAPTHA, IMPORTED AND INSPECTED.

TABLE 2.

Years.	Imperial G
1881	$1,111,3
1882	1,226,9
1883	1,110,5
1884	1,231,9
1885	1,211,1
1886	1,584,4
1887	1,511,4

IMPORTS OF CRUDE AND REFINED PETROLEUM

TABLE 3

Province.	1886.		1887.	
	Gallons.	Value.	Gallons.	Value.
Ontario	1,563,864	$179,756	1,688,611	$174,768
Quebec	759,312	69,526	805,197	69,527
Nova Scotia	699,480	66,690	762,346	63,096
New Brunswick	804,911	82,636	820,639	61,697
Prince Edward Island	170,736	18,818	173,852	13,793
Manitoba	7,627	871	15,486	1,905
British Columbia	173,921	50,934	198,913	44,826
Total	4,179,851	$469,231	4,465,044	$429,612

CRUDE PETROLEUM IMPORTED

TABLE 4.

Years	Imperial G
1885	2,5[illegible]
1886	2,595,4
1887	2,953,6

PHOSPHATE AND MANUFACTURED FERTILIZERS.

The total quantity of phosphate (apatite) shipped from the Canadian mines in 1887 is shown by direct returns received to have been 23,690 tons, the total value of which at the mines may be estimated to have been about $319,815, if $13.50 is admitted for the average spot value of a ton. Summary.

Compared with 1886, it is an increase in the marketed production of 3,195 tons; the increase in the value cannot be fairly ascertained, the average price given for 1886 being probably too high.

The production may be divided as follows:—

Quebec mines, Ottawa county	19,589 tons.
Ontario mines	4,101 "

Returns were received from eleven producers in Ottawa county, employing about 456 men; and from five producers in Ontario, employing about 130 men; it must be understood that in some cases the men were not employed all the year.

The exports of apatite since 1877 were given in the report for 1886. Exports. The following table 1 shows the exports for 1887 by provinces and the destination of the product, but it must be remembered that the great bulk of what is produced in the Ontario district is first shipped to Montreal, and that Quebec is thus credited with more than the production of the mines from the county of Ottawa. Table 2 from the mining and mineral statistics of Great Britain supplements the information as to the destination of our apatite exports, and as to the proportion the Canadian phosphate bears on the English market to the total phosphate imported each year in Great Britain:—

EXPORTS OF PHOSPHATES. YEAR 1887.

TABLE 1

PROVINCE.	Tons.	Value.	Destination.
Ontario	705	$8,277	All to United States
Quebec	22,447	424,940	All to Great Britain and Germany.
Total	23,152	$433,217	

EXPORTS OF CANADIAN PHOSPHATE TO GREAT BRITAIN COMPARED WITH TOTAL IMPORTS OF PHOSPHATES THERE

TABLE 2.

Year.	Canadian Apatite.		Total Phosphates.		Proportion of value of C Apatite to the value o Phosphates Importe Great Britain
	Long Tons.	£ stg.	Long Tons.	£ stg.	
1882	8,187	39,851	199,428	613,198	6.5 per cent.
1883	16,531	66,714	246,945	813,825	8.2 "
1884	15,716	52,370	219,225	643,851	8.1 "
1885	21,484	76,179	238,572	628,027	12.1 "
1886	18,069	63,490	223,111	526,885	12.0 "

This table shows that the proportion of the value of Canadi tite imports to that of the total imports of all phosphates of Great Britain is steadily increasing; in 1886 it had reached cent., or double what it was in 1882.

Manufactured Fertilizers

The following statistics though not quite completed may p interest in connection with the manufacture of fertilizers country. The industry is merely in its infancy in Canada, b probably before long attain large proportions, thanks to the resources of this country in many of the raw or other m used in this manufacture such as phosphate, gypsum, marls, (for making the acid), bones, fish and other manures, &c.

Production

Returns of three producers show a total quantity of fertilizers factured and marketed during the year of 498 tons, of a value works of $25,943. The return of Messrs. Jack & Bell of Halif not been received. There were 221 tons of Canadian apati sumed in that manufacture, and also small quantities of the fol minerals:—sulphate of ammonia, nitrate of potash, kainite and sulphate which were imported.

Land plaster used in the country

As stated on page 30 it is estimated that about 12,000 ground gypsum were used in the country as a fertilizer durin year.

Exports and imports.

Table 3 below shows that considerable quantities of bones ported for use in the manufacture of fertilizers, and table 4 e the imports of fertilizers and of the raw minerals used in that facture.

EXPORTS OF BONES FOR THE LAST THREE FISCAL YEARS BY PROVINCES

TABLE 3.

Province.	1885.		1886.		1887.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
Ontario	35,694	$35,222	39,805	$35,148	30,084	$24,169
Quebec.	19,212	15,311	60,782	44,451	21,922	12,797
Nova Scotia	5	5	130	150	1,483	1,066
New Brunswick.....	850	1,398	2,793	2,485	2,575	1,944
P. E. Island........	....	....	405	540	....	....
Manitoba	2,940	1,169	37,379	12,001	26,160	7,844
British Columbia....	502	240	214	120	346	344
Totals	59,203	$53,345	141,508	$94,895	82,570	$48,164

IMPORTS OF FERTILIZERS AND OF THE RAW MINERALS USED IN THAT MANUFACTURE IN 1887.

TABLE 4.

Articles.		Quantity.	Value.
Ground Gypsum..........................	lbs.	36,882	$ 375
Potash, German mineral................	"	15,313	935
" muriate and bichromate of (crude).	"	573,773	31,641
Kainite	"	2,700	112
Sulphate of Ammonia	"	53,555	1,526
Fertilizers..................................		....	7,749
Bones (crude and dust)................	"	11,760	677
Total................		....	$43,015

THE IRON ORES AND PHOSPHATE DEPOSITS IN ARCHÆAN ROCKS OF CANADA.

Object of paper

The object of this paper is to present in a concise form clusions arrived at by the writer as to the mode of occurren iron ores and phosphate deposits in the Archæan rocks o after a careful and minute study of many of these deposits in and phosphate districts of Ontario,* and in the counties o and Pontiac in Quebec. It is here presented on account of the bearing that it may have on the future developments of these i deposits, as it is hoped that it will be found to be a strong en ment for the working of many of these deposits in depth as guide in the following of their irregular structure and a he further discovery of new deposits of these minerals.

Origin of deposits.

We think we may say that our conclusions will be foun greatly at variance with the views generally admitted here in expressions of which have been published principally in the reports of the Geological Survey, and especially in the "Ge Canada," 1863, and in the well-known subsequent reports of I Dr. Harrington, and H. G. Vennor. For indeed we believe have gathered year after year strong and clear evidence to sh not only our deposits of iron ores in the Archæan rocks a eruptive or igneous origin, but also that our deposits of pl are exactly similar and have also the same origin. This we are treating here of the deposits of these two minerals as we believe that they are exactly analogous, and that wh be said for one is applicable to the other. As far as the i are concerned, the view of their deposits in the Archæan roc of an eruptive origin is far from being a new one, and has b by a great many eminent geologists in many countries, pri I believe, in France, Norway, and Sweden, and also by som English and American geologists. In the case of the pl (apatite), the eruptive or igneous origin has also been adv Norway and in France, but by a smaller number of observers, on account of the fact that the apatite deposits are not so n as those of iron ores, and thus the opportunities for exa and report were less frequent. Here in Canada, this eruptiv of the apatite as well as of the iron ores has always been d far: and if my conclusions were not backed by so many fac of which were only brought to light in the workings of the the last few years, I would feel somewhat reluctant to go thus

* Counties of Haliburton, Victoria, Peterboro, Hastings, Frontenac, Leeds, L Renfrew.

against the views already arrived at in this country by several very able men, but these facts were repeatedly observed and have been very carefully ascertained.

The principal among these observed points are the following:— Observations.

1. About 30 different deposits of iron ores (principally magnetite, though sometimes hematite) have been geologically surveyed by us * in the Madoc and Marmora region of Ontario, and were found to occur in the form of irregular veins around and always in close proximity to a large granite mass or to dykes and bosses of granite derived from it. The granite intrusions clearly cut across the Archæan crystalline limestone and schists and the deposits of iron ores are also manifestly veins cutting in a like manner across the Archæan rocks.

2. Away from the main granitic bodies, in the region covered by the map above referred to, there are no large deposits of iron ore, and when small quantities occur there can be seen almost in every case a small dyke of granite along the iron ore; so that the intimate connection of the two cannot be doubted.

3. An exactly similar connection was also observed between the iron ore deposits and intrusive igneous masses in a more extended region of several thousand square miles, also geologically surveyed by us,† and comprising parts of the counties of Hastings, Peterboro, and Victoria, in Ontario. There the iron ore deposits such as those forming the Blairton Mine, Orton Mine, Baker Mine, Emily Mine, Coe Hill Mine, Jenkins Mine, the Snowdon Mines, etc., were always found to be intimately connected in the manner described above with many varied kinds of igneous rock such as granite, granulite, pegmatite, mica syenite, hornblende syenite, diorites and diabases.

4. In the region north of Kingston, in the Counties of Frontenac, Leeds, Lanark, Renfrew, Pontiac and Ottawa, many deposits of iron ores and many deposits of phosphate were observed also in the same association with igneous rocks, and both cutting through the Archæan rocks. In the case of the phosphate the igneous rock was often the rock termed by Dr. Hunt "pyroxenite," but at other times it was a pegmatite or a mica syenite or a pyroxene syenite. In that region the iron ore and the phosphate have been found in the same deposits as witnessed by the evidence at the Foley Mine, the Forsyth Mine, and especially at the Blessington Mines where the writer observed the apatite and the magnetite together in the workings of nine different pits, and where at the time of his examination last summer there were

* This map on the scale of 40 chains to one inch, and comprising an area of 125 square miles, is now in the hands of the engraver and is expected to be ready shortly. It will be accompanied by a report in which the details of our observations will be given at length.

† A map of about 3,500 square miles covering this region, has been prepared and is expected to be published at the scale of 4 miles to the inch in the course of a year or so.

between 500 and 600 tons of iron ore and about 1500 tons of ph
on the dumps, the two minerals having been taken out from th
pits.

5. In the two regions mentioned above the apatite and ma
were often seen to be amongst the component elements of these
or dykes of igneous rocks, which rocks were observed to acc
these minerals in their deposits as a veinstone of quartz or
carries other minerals in other veins.

Conclusion.

Considering all this and knowing that similar facts have al
observed in other countries especially in the States of New
and New Jersey, and in Norway and Sweden, it is only natur
we should conclude, like many other geologists have done b
those countries, that the iron ore and phosphate to be found
Archæan rocks are the result of emanations which have accom
or immediately followed the intrusions through these rocks o
varied kinds of igneous rocks which are no doubt the equiv
the volcanic rocks of to-day. These deposits then are of
seated origin and consequently the fears entertained, princip
our phosphate miners, that their deposits are mere surface p
are not well founded. These fears are no doubt partly the
of the belief which has been somewhat prevalent that the
in them was the metamorphic equivalent of the phosphate
of younger formations, and it may be also that they have
from the fact that the apatite is irregularly distributed in
deposits and is often suddenly replaced by rock; this is not s
the case in the iron ore deposits which are on a larger scale. N
withstanding this, when the deposits are properly understood t
we hold they are, igneous dykes and veins accompanying the
rocks, it will be easily seen why in the deposit itself the ec
minerals can be suddenly replaced by rocks which may be sai
nothing else but the gangue. If this origin is understood
besides facilitate and encourage the working of these dep
depth, because the accompanying igneous rock, forming a
a dyke alongside of the deposit will be easy to follow and,
if it is apatite or iron-bearing at the surface, it will alway
guarantee that it will also be in depth, as each separate mass of
rock is generally quite constant in composition.

PRECIOUS STONES.*

By George F. Kunz.

Although no mining for precious stones is carried on in Canada, and it can scarcely be called a gem-producing country, yet it furnishes a number of stones that are of more than passing interest to the mineralogist, and of some value in jewellery and the arts. A number of gem minerals, not of gem quality, are found here in examples of such stupendous size and wonderful perfection that they have found prominent places in the cabinets of the world, and are even more prized as such than cut stones from other localities. Their mineralogical value gives them no small commercial importance. For instance, the magnificent zircon crystals, occurring as individuals up to 15 lbs. in weight, many fine ones weighing nearly a pound, and the beautiful twin crystals of the same mineral; the black titanite in simple and twinned crystals up to 70 lbs. each; the vast quantities of amethyst from Lake Superior; the ouvarovite or green chrome garnet from Orford, and the white garnet crystals from near Wakefield, are some of the most notable of Canadian occurrences. Not the least wonderful are the apatite crystals, one weighing over 500 lbs., which are found of such size and beauty that the rich green variety, especially, would do to work into ornaments similar to those made from fluorite, which it exceeds in hardness.

What Canada has produced in precious and ornamental stones was well shown at the Centennial Exhibition, Philadelphia, 1876, and at the Colonial and Indian Exhibiton, at London, in 1886. The finer minerals have found their way into the well-arranged collection of the Geological Survey of Canada, at Ottawa, the British Museum, the Mineralogical collection of McGill College, which contains the cabinet of the late John G. Miller, and the Provincial Museum of Nova Scotia. Many of the finest specimens, in full series, grace the cabinets of Mr. Clarence S. Bement, at Philadelphia, King's College, Windsor, N. S., School of Mines, New York, which contains the collection of the late Dr. Henry How, Walter G. Ferrier, Montreal, Colonel W. J. Wilcox (deposited at the United States National Museum), Amherst College, at Amherst, Mass., Prof. O. C. Marsh, New Haven, Conn., and the New York State Museum, at Albany, N. Y.

The field in Canada is so vast that although much has been done in the way of prospecting of late years, only a small part of the territory has been thoroughly gone over. With the great resources developed by the opening of the Canadian Pacific Railway many new localities

* Specimens from the localities marked with an asterisk are in the Geological Survey Museum, Ottawa.

will doubtless be brought to light in the next ten years, and im
additions made to the foregoing list.

DIAMONDS—have not been found at any locality in Britis
America.

SAPPHIRE.—Corundum, in red and blue crystals has been foun
limestone near Burgess, also in grains disseminated through
made up of felspar, quartz, calcite and titanite, in contact w
crystalline limestone. These grains are of a light rose-red to
blue color, and are of no gem value, nor in quantity suffic
commercial use. Chrysoberyl, alexandrite or chrysoberyl cat's
not been observed in Canada. Chrysoberyl has been found in
however.

SPINEL.—In the seigniory of Daillebout small translucent
drons of blue spinel are found in a bed of micaceous limest
from Wakefield* come pink and dark bluish spinels in round
crystals and opaque light blue cubes nearly an inch in diamete

Very interesting black spinels in brilliant crystals, one to tw
in diameter, occur in Burgess and Bathurst* townships, Ont
a vein of them has been traced for a mile in one direction. T
also associated with fluorite in the township of Ross, Ont. None
possess any gem value, however.

TOPAZ (?).—At the London Exposition, 1862, Mr. McDonal
ited two topazes (?) from Cape Breton, one in the rough, and t
which had been cut at Pictou, half an inch in length and of
color, the variety of this mineral peculiar to Brazil, which lead
inference that these stones may have been citrine or artificiall
orized smoky quartz, and not the true mineralogical topaz.

EMERALD.—Emeralds have not been observed in Canada. A
very fine aquamarines have been found in Maine, adjacent to the p
of Quebec. Little if any beryl of value for gems has been disco
Canada. Pale green, well defined crystals have been reported
Bigsby at Rainy Lake, 230 miles west of Lake Superior.
Berthier* and Saguenay* Cos., Que., some crystals over an
diameter have been found.

ZIRCON.—The zircons of Ontario, especially those from Lake
and Sebastopol* and Brudenell* townships, in Renfrew County,
most remarkable known for beauty, size, perfection and ric
color. An occasional crystal top or a small fragment will
gem of the hyacinth variety, but they rarely exceed a carat in

Some of these individual crystals weigh about 15 lbs., and are more than four inches in diameter. One was observed three inches in diameter and nearly a foot in length. On the land of E. J. Gallagher, 25 miles west of Eganville, Ont., in Brudenell township* fine crystals are obtained. The twin zircons from Lake Clear are especially beautiful and interesting, one of them measuring nearly four inches in length, and many thousand dollars worth have been sold as specimens. Short's Claim,* on the north shore of Lake Clear, yields the finest twin zircons. Perhaps the finest twin crystals ever found and one of the best single crystals are in the British Museum Collection, while perhaps the finest series of this mineral is in the collection of Mr. Clarence S. Bement, of Philadelphia. An enormous single crystal is in the cabinet of the Academy of Natural Sciences at Philadelphia. In Burgess and adjoining townships occur some fine crystals, not so large as those from Renfrew, it is true, but of exquisite polish and highly modified forms; in Templeton* and, near Grenville, Que.,* especially four miles north, are found smaller crystals, often cherry red and transparent, that would make small gems. Highly modified crystals, associated with wollastonite and graphite are also found at this place.

Zircon is now mined by the ton in the United States and about $150 per ton is paid for it, because of the earth it contains (zirconia) which is used in the hoods for the new incandescent gas burners. The zircons are obtained by washing out the soil resulting from the decomposition of felspathic rocks.

TOURMALINE.—Tourmaline in green crystals is found in Chatham township,* Que., and the green and red (rubellite) varieties in Villeneuve township,* Que. Brown tourmalines are frequently met with in the Laurentian limestone. Fine crystals, rich yellowish or translucent brown in color, often occur imbedded in a flesh-red limestone at Calumet Falls, Que.,* and also in the townships of Ross, Ont.,* Clarendon and Hunterstown, Que. These furnish an occasional gem. Slender crystals in white quartz occur at Fitzroy, Island Portage and Lac des Chats, and of inferior color at McGregor's Quarry in Lachute,* Ont. Black tourmaline of no gem value is found at a number of localities, principally at Yeo's Island, near the upper end of Tar Island, one of the Thousand Islands. It occurs in large crystals at Murray Bay, Cap Tourmente, Que., and in white quartz on the 18th lot, 4th range of Bathurst,* Ont.; in the granitic veins in the township of Ross,* Ont.; on Roche Fendue channel, on Camping Place Bay, on Charleston Lake in Lansdowne, Ont., and on the west side of the North River at St. Jerome, Que.; in Blythfield, on the Madawaska, and at N. Elmsley, and Lachute,* Ont., St. Felix and Calumet Falls,* Que. The velvet black, fibrous tourma-

line found at Madoc* and Elzevir gives a blue powder and is evidentl an indicolite, like the variety from Paris, Maine.

PHENACITE.—Phenacite has not yet been observed in Canada, bu was recently identified by the writer at Stow, Maine.

GARNETS.—Almandite garnets occur plentifully in magnificent crysta in mica schist along the Stickeen River* in British Columbia. Owing their perfect form and polish the faces of these crystals are the mos beautiful in the world. Although they are not transparent enough t be of value to cut into gems, if obtained in sufficient quantity the would be useful for watch jewels.

Beds of nearly pure red garnet rock, from five to twenty-five fee thick, are sometimes met with in the gneiss at St. Jerome, Que., an in quartzite in Rawdon, and Marmora townships, Ont., and at Baie S Paul,* Que. Some small pieces would afford gems of little value, bu the stone is of considerable use in the arts as a grinding material an for sand paper. The large red garnet, disseminated through a whit oligoclase gneiss, at Lake Simon, would not afford gems but if polishe with the rock would afford an ornamental stone.

Andradite garnet is found on Texada Island, B. C.,* in fair crystals not of gem value, however.

Essonite, cinnamon-colored garnet, the so-called hyacinth of th jewellers, is found in small crystals in Grenville, Que., but not of gem value, and in fine crystals, associated with idocrase, in Wakefield,* Que But few of these would furnish even small gems.

Grossularite, white lime-alumina garnet, is found in Wakefield* an in Hull in considerable quantity, in veins lining the crystalline lime stone, and associated with essonite, idocrase and pyroxene. This i the most remarkable locality for this mineral, superb crystals tw inches across having been found there, as well as groups of crystals foot across. In color the crystals vary from colorless to light yellow and light brown, and some of them are transparent enough to afford colorless gems of from one to two carats in weight.

Melanite, black garnet, is found in Marmora,* Ont., but this variety has no use in jewellery.

Ouvarovite, or green chrome garnet, found in Orford,* is one of the most beautiful known occurrences of this rare mineral. The crys tals, which are transparent dodecahedrons, rarely over one-eighth of an inch in diameter, and of the deepest emerald green color, are found lining druses in cavities of crystalline limestone, often on the chrome pyroxene and associated with millerite. If it were not for the small size of the crystals, this would be a gem of the highest rank. A few crystals of this mineral have been found in Wakefield, some of which

rival in size any that have been discovered, the largest measuring nearly one-half inch in diameter. They are of a fine green, but opaque, and are sometimes filled with a yellow centre.

IOLITE has not been observed at any Canadian locality.

QUARTZ.—Rock crystal is found in many localities of Canada, especially in veins with amethyst in the Lake Superior region, but it has not been observed of sufficient size to afford crystal balls or other art objects.

The small doubly terminated crystals found in the limestone of the Levis and Hudson River formation, and familiarly called "Quebec diamonds," are sold as souvenirs to tourists, as the Lake George diamonds are in the United States.

Fine crystals are found in the soil in Lacolle, Que., and in the cavities of the calciferous formation in many places in beautiful limpid crystals.

Larger crystals have been found with smoky quartz near Paradise Bay, N. S., (see Smoky Quartz), also in the geodes on agate throughout the entire Bay of Fundy district, and on the Musquash River, N.B., at Cape Blomidon, N. S., etc.

Milky quartz is found all through Canada, but it is never of any value in the arts except for porcelain. Rose quartz is also found at many localities, especially at Shelburne, N. S. It is of little value in the arts, but has been made into various ornaments and charms. Smoky quartz in fine groups occurs in the same veins with amethyst on both Lake Superior and the Bay of Fundy, so uneven in color, however, as to afford gems of little value. It has been found in immense crystals in the vicinity of Paradise River, also near Bridgetown and Lawrencetown, Annapolis County, N.S., from a light yellow color to the dark, smoky "cairn-gorm." Dr. How mentions a crystal 13 inches high and 6 inches in diameter. Single crystals weighing 100 lbs. each have often been obtained from the decomposing granite and have been piled up with the stones from the fields, near Paradise River, and loose in the soil. It occurs in crystals about two inches in length at Mill Village, Lunenburg Co., N. S., and at Margaret's Bay, Halifax Co., N. S. In King's College cabinet there is a specimen of the dark, almost black variety known as "Morion," with crystals one-half inch across. When transparent, smoky quartz has considerable sale for jewellery under the name of cairngorm, Scotch or smoked topaz; when partly decolorized to a yellow and yellowish brown, as Spanish or Saxon topaz.

Amethyst is found in some form in nearly every vein cutting the cherty and argillaceous slates around Thunder Bay,* on the north shore of Lake Superior. At Amethyst Harbor* this mineral consti-

tutes almost the entire vein, and numerous openings have bee
to obtain it for tourists who visit the spot. Thousands of dolla
are annually sold here, and as much more is sent to Niagar
Pike's Peak, Hot Springs, and other tourists' resorts, as well
mineral dealers. Surfaces several feet across are often cove
crystals from ½ inch to 5 inches long, rich in color, and havin
polish. Sometimes, especially when large, the crystals have a
of a rusty brown color, owing to the oxidation of the
goethite. This is one of the most famous occurrences of this
regarded as mineral specimens, but the purple color is very u
distributed, resembling the Siberian not the Brazilian in this
and as the crystals are not transparent like those from Sibe
afford very few gem stones of value.

In Nova Scotia, however, fine amethysts occur in bands, v
geodes at Partridge Island, Cumberland County, N. S., surfac
square being covered with splendid purple crystals an inch
Dr. Gesner mentions a geode that would hold about two gallon
at Cape Sharp, nearly opposite Blomidon, N. S. Another, lini
of chalcedony with concentric bandings, was found at Sand
Digby County, N. S., and weighed 40 lbs. De Monts is said
taken crystals from Partridge Island to Henry IV. of Franc
they greatly pleased, and a crystal from Blomidon was am
French Crown Jewels twenty years ago. A bushel of cryst
obtained by the late Dr. Webster, of Kentville, N. S., in di
single well. Dr. Gesner also states that he had seen a band of a
some feet in length and perhaps two inches thick, about a mil
Hall's Harbor, N. S. Other localities are the south side of
Mountain, Cape D'Or, Mink Cove, Scot's Bay, in Nova Sco
Little Dipper Harbor and Nerapis in New Brunswick, and oth
ities along the Bay of Fundy.

The beautiful masses of straight, concentric and irregular
amethyst (banded with quartz and agates) (see above) found
Scotia on the Bay of Fundy, are somewhat similar to a varie
abroad, and used for ornamental purposes, principally for clo
and jewel caskets. The material is slit into plates so thin th
are often strengthened by cementing them on plates of glass,
colors are enhanced by setting the plates so that the light c
through. Dr. How mentions prase, green quartz, as occurring
Point, N. S. A beautiful hyaline quartz is found at Scot's Bay

Sagenite (Flesche D'Amour, or Venus' hair stone) is repo
Dr. How from Scot's Bay, N. S. It is transparent quartz pe
with needles of rutile.

AGATE, CHALCEDONY AND CARNELIAN.—Agates are found along the entire coast of Lake Superior in great abundance and often of considerable size and beauty. The finest in this region, however, are derived from the trap of Michipicoten Island,* Ont. They also occur on St. Ignace and Simpson's islands, Ont., on the former only as nodules in the trap. Both chalcedony and agate occur also as veins filling dislocations and cracks which penetrate the trap in several directions. In the Thunder Bay district they are associated with amethysts, occuring also as pebbles. Although these agates are often of rich color, and are beautifully veined, they are rarely over two inches across. Many are sold to tourists for ornaments, and many others could probably be disposed of if a little more attention were given to cutting and polishing them. As natural agates their color is exceptionally fine. Nearly all the large agates sold in this region are foreign material as well as of foreign coloring and cutting. Agate pebbles, known to the collectors as Gaspé Pebbles,* are found in the conglomerate of the Bonaventure formation, on the Baie des Chaleurs, Que., and along the shore of Lake Superior, in the vicinity of Goulais Bay, and especially on the St. Mary's River. Handsome agate and chalcedony in nodules and veins are of frequent occurrence on the south shore of the Bay of Fundy,* between Digby and Scot's Bay, N. S. Large masses of agate have frequently been found on this coast. Gesner mentions a mass of 40 lbs. weight made up of curved layers of white, semi-transparent chalcedony and red carnelian, forming a fine sardonyx. A mass showing distinct parallel zones of cacholong, white chalcedony and red carnelian, was found a few miles east of Cape Split, N.S.* When polished it resembles an aggregation of circular eyes, and hence the name eye-stone, or eye agate is applied to it.

At Scot's Bay, N. S., large surfaces of rocks are studded with these minerals. Fine specimens are also found at Blomidon, and at Partridge Island, N. S. Fine agates and carnelians occur at Digby Neck, six miles east of Sandy Cove, Woodworth's Cove, west of Scot's Bay, and at Cape Blomidon, N.S. Fine agates, chalcedony and carnelians are also found in New Brunswick, at Darling Lake, at Hampton, near the mouth of the Washdemoak River, at Dalhousie and on the Tobique River, in Victoria County.

An unique blue chalcedony, rich brownish green by transmitted light, is mentioned by How, from Cape Blomidon, N. S. Agate often occurs in layers forming an onyx in the Bay of Fundy and Lake Superior regions. Beautiful ones are found at Two Islands, Cumberland County, near Cape Split, at Scot's Bay and at Parrsboro, N. S. At the Queen Charlotte Islands, B. C., they occur abundantly at some localities, being derived from the miocene-tertiary rock.

Beautiful moss agates are found at Two Islands, Cumberland and near Cape Split, Partridge Island, also at Scot's Bay County, N. S., exceptionally fine at the latter locality. Chr of fair color has been found in the Hudson's Bay district, on B Island.*

Silicified woods are found to some extent in the north-we tories* and in British Columbia. This is a beautiful ornamen when the colors are fine, and it is highly polished.

Jasper conglomerate exists in mountain masses, along quartzite masses of the Huronian series, for miles in the count of the Bruce Mines,* on Lake Superior north of Goulais Bay St. Mary's river about four miles west of Campment d'Our' two places on the east shore of Lake George, and on Lake Hu It is a rock consisting of a matrix of white quartzite, in w pebbles often several inches across, of a rich red, yellow, black jasper, and smoky or other colored chalcedony, whic remarkably striking contrast with the pure white matrix. ceptible of a very high polish, and has been made into a grea of ornamental objects, such as vases, paper weights, etc. So beautiful mosaics have been produced by using the rock and pebbles. The stone occurs in thick bands which extend for n large boulders of it are scattered along the shores of the lake a Within half a mile of the northern extremity of Goulais B there is a ridge containing several varieties of it.

Large quantities of rich, red jasper are found in Hull,* Que and red occur at Handley Mountains, Annapolis, Picton, C Hope, Blomidon*, N.S.; at Belleisle Bay, King's County, Gran Darling's Lake and Hampton, near the mouth of the Was River; at Red Head and at the Tobique River, Victoria Co Woodworth's Cove, west of Scot's Bay, and all along the sho Bay of Fundy from Sandy Cove,* N. S. Near the head of S Bay lie large blocks of red, yellow† and yellowish red jasp banded, but generally impure, however.

Considering the abundance of this jasper it seems strange beautiful an ornamental stone should have been so long negle the recent improvements in sawing and polishing hard stones mental purposes will doubtless bring it into extensive use in future.

Heliotrope (bloodstone) in good specimens is of rare occur the North Mountain, Bay of Fundy, N. S.*

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† Specimens of a rich yellow jasper from Pt. La Lime, Restigouche County, N the Survey Museum, Ottawa.

Dr. Gesner mentions finding two small nodules of opal, resembling pieces of wax, at Partridge Island, N. S.

Semi-opal has been found at Partridge Island in fine specimens, at Grand Manan, N. B., and other localities in that vicinity.

Cacholong has been found associated with chalcedony in Nova Scotia on the Bay of Fundy.* The hornstone found at Partridge Island admits of a fine polish and is of some use as an ornamental stone.

JADE.—Jade (nephrite) in the form of archæological implements, has been found from the straits of Fuca northward along the entire cost of British Columbia and the northern end of Alaska. At the latter place it is closely allied with other minerals, such as the new form of pectolite, and is found with other relics of various kinds about shell heaps and old village sites, in graves, or still preserved, although seldom used, by the natives. It is also found as far inland as the second mountain system of the Cordillera belts, represented by the Gold, Cariboo and other ranges, principally among remains from Indian graves, and along the lower portions of the Fraser and Thomson rivers, within the territory of the Selish people. In the interior it is of rare occurrence, the coast Indians having used the tools in the construction of their houses and canoes, which are much superior to those of the interior. Dr. Geo. M. Dawson procured about sixty specimens for the Survey Museum, and at McGill College there is a fine series together consisting of 44 adzes, 6 drills, 2 boulders and 9 other objects. Dr. Dawson says: "It is among the highly altered and decomposed rocks of the Carboniferous and Triassic that silicates of the jade class might be expected to occur, and I feel little doubt that when these rocks are carefully investigated they will be found to be the sources of the jade." The Indians of the region, however, have usually if not invariably obtained their supply from loose fragments and boulders.

Jade is also reported from the Rae River and from the Hudson's Bay district by Mr. Rae.

This stone is highly esteemed in China and India, where it is carved into fine art objects and sold in large quantities,—a single object requiring the work of a lifetime, and selling for thousands of dollars. In New Zealand it is made into charms, trinkets, paper cutters, and in copies of native aboriginal objects.

PECTOLITE.†—Among the minerals sent to the United States National Museum from Point Barrow, Alaska, was a substance which Professor F. W. Clarke identified as pectolite. It had a specific gravity of 2.873, was white, grey and pale green in color, and about as

† A specimen of this mineral from Cathcart Point, Lake Superior, is in the Geological Survey Museum, Ottawa.

hard as jade. Almost simultaneously it was described abroad Mercier has in the Geological Survey Museum several interestin of this material from northern Alaska, and a number of Indi ments are in the museum of McGill College. During the Professor W. P. Blake handed the State Mining Bureau of Cal description of a vein of this mineral which occurs in Tebama California, where it can be broken out in pieces four inches larger. When freshly broken the color is sea green, but on we it becomes white. This material would also make a valual mental stone, and Professor Blake's discovery leads to the that it may be found at many other places on the Pacific co objects made of it have been discovered both in Alask California.

Axinite.—Axinite in fine crystals was reported by Dr. Big a boulder of primitive rock at Hawkesbury, near Ottawa.

Epidote.—Epidote is found at many localities, though no form, except when with flesh colored felspar in the amygdalo on Lake Superior. This has been polished to form an odd or stone. At the falls of the Mingam river, Que., and in Ram ship, Ont., is found a peculiar, fine-grained, reddish gneiss, by veins of a pea-green epidote. It is very beautiful when Pale-green epidote with quartz is found on the Matane rive which forms mountain masses in the Shickshock Mountains, hard, susceptible of a high polish, and would be of value as mental stone.

Microcline.—Amazon stone (microcline) has been found topol,* Ont., and in Hull,* Que., in cleavages of good color.

Moonstone.—The Adularia variety of moonstone, simila Ceylonese, has not been observed in Canada.

Labradorite.—Labradorite, the most beautiful of all the felspars, exists in great quantities on the coast of Labrador,* esp Nain and on St. Paul's Island adjacent to it, where the finest kno in veins of some size, whence for over a century it has been br the ton for use in the arts. It occurs on Lake Huron, Ont., at Ca and the 10th range of Abercombie, Que.,* in fine cleavage inches in diameter and of rich color, shewing beautiful blue op at Morin, Que.* In Lewis County, New York, it is extensiv ried for building purposes, and polished into columns and oth for interior decorations.

PERISTERITE.—This beautiful variety of albite exhibits a peculiar bluish chatoyancy or opalescence, sometimes mingled with pale green and yellow, and called "moonstone." It is found in crystals and by the ton in large cleavable masses, containing disseminated grains of quartz, in veins cutting the Laurentian strata at Bathurst,* Ont., also in crystals on the north side of Stony Lake, near the mouth of Eel Creek, in Burleigh, Ont. in large opalescent cleavable masses of reddish albite, and on the 9th line or concession north of Perth, Ont., on the land of Robert McEwen. This beautiful material is especially adapted for use in the arts.

It is also reported by Mr. Hoffmann in specimens, showing beautiful blue color from Villeneuve,* Ottawa Co., Que.

PERTHITE.—Perthite occurs in large cleavable masses in thick pegmatite veins, cutting the Laurentian strata, and is often made up of flesh-red and reddish-brown bands of orthoclase and albite, interlaminated. When cut in certain directions it shows beautiful golden reflections like avanturine, and being susceptible of a high polish, is adapted for an ornamental stone or for use in jewellery. It is also found in considerable quantity at Burgess,* Ont., about seven miles southwest of the town of Perth, and near Little Adams Lake on what was formerly called Dobey Farm.

SUNSTONE.—Sunstone, avanturine felspar, has been described by Dr. Bigsby in the form of a largely crystallized flesh-red felspar, constituting part of a granitic vein traversing gneiss, 20 miles east of the French river, on the northeast shore of Lake Huron, and occurs in fine specimens at Sebastopol,* Ont.

OBSIDIAN.—Obsidian has been found in British Columbia,* but it has little value except for the cheaper jewellery, and is rarely used for that purpose.

PORPHYRY.—The porphyries which cut the Laurentian limestones in the townships of Grenville* and Chatham,* Que., form a dike running east and west 20 feet in breadth. They have a dark green or brownish black base, homogeneous and compact, containing crystals of red orthoclase, and admitting of a high polish, which strongly recommends it for use as an ornamental stone.

GRAPHIC GRANITE.—The pegmatite at Montgomery's clearing on Allumette Lake, five miles above Pembroke, Ont, consisting of a brownish-red orthoclase with white quartz is a beautiful ornamental stone, and admits of a good polish.

Idocrase.—Idocrase in wax-yellow crystals imbedded in li
found in Grenville, Que., in crystals of remarkable perfectio
brown color, in a white calcite near Wakefield,* Que., on Frye
N.B., and in large brown crystals at Calumet Falls, Que. Son
would cut small gems, for which there is slight demand to
the initial "I" in sentimental jewellery.

Pyrite.—Pyrite is found at many localities, but nowher
perfection. It was extensively cut and polished for jewellery
ago, but was superseded by the introduction of steel jeweller

Hematite.—Hematite (specular iron) occurs finely crys
Cape Spencer, and exceptionally perfect and brilliant at Dig
N. S., Sussex, King's County, and Black River, St. John Co., N
fibrous form of red oxide of iron is extensively worked into
in England and Germany; but it has not been found of suffic
in Canada to warrant working, as it can be cut so much mor
abroad. All the hematite jewellery of the Lake Superior re
lieved to be not only of foreign workmanship but foreign ma

Olivine.—Although olivine, chrysolite or peridot, as it is
known, is found at a number of localities as a rock constituent,
in the form of imperfect olive and amber-colored crystals one-h
diameter, at Mount Royal, Montarville,* Mount Albert and R
Que.; it has not yet been observed of sufficient clearness and
to afford gems.

Andalusite.—The andalusite, found on Lake St. Franci
flesh-red prisms not exceeding one-tenth of an inch in dian
also in black crystals and the variety known as *chiastolite mac*
stone, is sold abroad for use in jewellery. It also occurs at G
N. S., in fair macles.

Pyroxene.—The deep chrome-green pyroxene found at Orfo
is of special interest. Many fine crystals have been found.
ally they are transparent and would afford gems. The lil
variety from Grenville,* Que., does not admit of a fine polish

Staurolite.—Staurolite has been found at several localitie
Scotia, more especially at Guysboro.* This mineral when
crosses finds some sale for charms in Switzerland. A legend
by many inhabitants of Brittany, attaches a symbolic meanin
representing that they have been dropped from the sky.

Diopside.—Diopside is found as a rock constituent at many
in the Laurentian area. At Calumet Falls, Que., it occurs i
six inches long though not of gem value.

SCAPOLITE.—Scapolite, wernerite, occurs in large cleavable masses in a limestone at Grenville,* Que., and Bathurst, Ont. When free from the lilac-colored crystals of pyroxene with which it is associated it admits of a good polish, but is of little value in the arts.

ILVAITE.—Ilvaite was found in a boulder nearly a foot in diameter in the vicinity of Ottawa, Ont.,* and is believed to form a bed in the Laurentian series. It has little value as a gem, but is occasionally used for the letter "I" in sentimenal jewellery.

SODALITE.—Sodalite in fine blue grains has been found in the granite of Brome, Que., and at Kicking Horse Pass,* B. C., in seams at Montreal,* Que., and in veins several inches wide on the line of the Canadian Pacific Railway, by Dr. B. J. Harrington. It is occasionally used in the arts.

LAZULITE.—Lazulite is reported from the Hudson's Bay district, but of little gem value even when it is of fine color.

KYANITE.—Kyanite has been found in Vermont adjacent, but has not been observed in Canada.

PREHNITE.—Prehnite is associated with native copper and calcite in the Lake Superior region,* where it is often of a rich green color in spherical masses of crystals an inch across, or in aggregations even larger affording a curious but pleasing green stone resembling a chrysoprase. Prehnite in fine specimens occurs at Clifton, Clark's Head and Black Rock, King's County, N. S.

TITANITE (Sphene).†—The titanites of Canada have a world wide reputation, not only for their color, polish and the perfection of the crystals but also for their great size. A twin crystal of this mineral has been found on Turner's Island, in Lake Clear, weighing 80 lbs. They are found abundantly in this region, associated with apatite. The crystals are generally of such deep brown color as to appear black, and it is rare that even a small transparent gem could be cut from them. As crystals, however, they are unexcelled, and many thousand dollars worth have been sold as specimens. The finest are found in Renfrew County, especially in Sebastopol* and Brudenell* townships, Ont. Yellow crystals have not been observed as yet.

ZONOCHLORITE.—Zonochlorite, said by Hawes to be a chemically impure variety of prehnite, is yet distinctive enough as a gem stone to

† Fine specimens from Grenville and Hull, Que.; S. Sherbrooke, Ont.; and of a variety almost white from Brome, Que., are in the Geological Survey Museum, Ottawa.

entitle it to its name. It occurs in small rolled masses and i
at Nepigon Bay, Ont., and was described by Dr. A. E. Foote.
opaque green stone, beautifully marked and veined, and adn
high polish, and ought to find some sale as a local or tourist

CHLORASTROLITE.—Chlorastrolite, while not occurring on
shore of Lake Superior, is found at Isle Royale, and Mi
Island.* This beautiful, stellated gem stone, which is sol
siderable extent as an ornamental stone on all sides of the
purely American occurrence.

THOMSONITE.—Thomsonite of a red color, compact and fib
banded with green in a number of concentric rings, is fou
northern shore of Lake Superior, Ont., and Cape Split,*
pebbles vary in size from one-eight of an inch up to one inch
are quite extensively sold on all sides of the lake as an ornam
The pebbles when polished find a ready sale among the to
frequent that region. The green which Peckham and Hal
as lintonite, an uncrystalline green variety of thomsonite, c
the centre or band, making an effective gem stone, and is so
same purposes.

ILMENITE.—The ilmenite in the parish of St. Urbain,* at Ba
sometimes contains grains of a greenish triclinic felspar,
furnish an ornamental stone similar to the porphyritic menacc
at Cumberland, Rhode Island. It also contains rutile crystals,
however, to have value as gems, though adding to the be
material when polished.

LAPIS LAZULI.—Lapis Lazuli is specially mentioned in nea
early government grants as one of the gem stones reserv
Crown, but as yet it has not been observed at any North
locality.

NATROLITE.—Natrolite is found in stout crystals with other
Peter's Point and other localities on the Bay of Fundy,* and
Creek, Cape Blomidon, and Partridge Island, N. S. When tr
and of sufficient size, it is occasionally used as a gem to rep
initial N in sentimental jewelry.

APOPHYLLITE.—Apophyllite is often found along the con
Scotia on the Bay of Fundy,* principally at Cape d'Or, Isle
Partridge Island, and Swan's Creek just above Cape Blomidon,
cent crystals sometimes one inch or more across. It occasion
on agate and amethyst in the trap rock, and would afford

logical gem, as the pearly lustre produces a curious effect like that of a fish's eye, hence the name ichthyophthalmite, or fish eye stone. The color is generally white, but occasionally the crystals have a rich green tinge.

MONAZITE.: Hoffmann has described a part of a crystal from Villeneuve,*Ottawa Co., making this one of the most remarkable occurrences known. If transparent it would afford a hyacinth yellow gem, rather low in hardness.

APATITE.—This mineral, which has added so much to the mining industry of the Dominion, is found in greater quantity and in finer crystals than in any other country. The crystals are often of great size and perfection, one famous crystal from the Emerald Mine, at Buckingham,* Que., weighing 550 lbs. Magnificent crystals are found throughout Eastern Ontario, on the shores of Lake Clear,* several feet in length and of fine color; at Sebastopol* and elsewhere throughout Renfrew County,* and at Wakefield,* Templeton,* Portland* and Buckingham Townships,* Ottawa County, Que. The crystals are often partly transparent, and are of all shades of red brown, brick-red, and often rich, deep green, especially in Ottawa County, in which case they ought to have some of the uses of fluor spars as ornamental stones.

WILSONITE.—Wilsonite is found at Bathurst* and Burgess,* Ont., and Ottawa County,* Que., in masses of some size, associated with scapolite. The specimens are beautiful, the minerals often passing into each other. The rich, purplish-red color of this mineral, and the fact that it admits of a good polish, make it one of the most interesting of gem minerals.

FLUORITE.—Fluorite is occasionally found in purple crystals measuring several inches on a face, associated with and on the Lake Superior amethyst. Green and purple fluor often fills mineral veins in the Lake Superior region,* and veins in syenite opposite Pic Island, on the mainland. On an island near Gravelly Point, in a porphyry, it occurs in green octahedral crystals, with barite; in green cubes associated with calcite and quartz, at Prince's Mine, Ont., and in small, beautiful crystals near Hull,* Que. Fluor spar of a beautiful blue color is found at Plaster Cove, Richmond County, N.S., and also on the west side of the harbor of Great St. Lawrence, Nfld. Small purple crystals of great beauty are occasionally found on pearl-spar in the geodes at Niagara Falls, Ont., and elsewhere in the Niagara formation.* A green, compact variety occurs in white calcite associated with galena, in veins cutting the Potsdam sandstone at Baie St. Paul and Murray Bay, Que. This would work into an ornamental stone. It is frequently found all through the Laurentian rocks. When transparent, the various colors

are called purple (false amethyst), yellow (false topaz) (false emerald). It is rarely cut into mineralogical gems, compact, of good color, or beautifully veined, it is worked cups and other ornamental objects, known as Blue John, Spar, etc.

MALACHITE.—Malachite of gem value has not been found tent in Canada, although it occurs in nearly every locality wh and its ores are obtained. It has been observed at Sutton,*

AGALMATOLITE.—The agalmatolite found in Canada is n quality as to fit it for the uses of the Chinese figure stone.

JET.—Jet is found at Pictou, Pictou County, N.S., in fine has been pretty much superseded in jewellery by black ony little now used is mined at Whitby, Eng., owing to its supe ness, and the perfect facilities for working it there.

Further reference to this subject can be found in the works:—"Remarks on the Mineralogy and Geology of the of Nova Scotia, by Charles T. Jackson and Francis Alger, C 1832, 4to., page 116; "Geology and Mineralogy of Nov Abraham Gesner, Halifax, 1836, 8vo., page 272; "Catalog Mineral Localities of New Brunswick, Nova Scotia and Newf from the American Journal of Science and Arts, II. S XXXV., 1863, page 8; "Mineralogy of Nova Scotia," by He Halifax, N.S., 1868, 8vo., page 217; "Geology of Canada— the Geological Survey from its Commencement to 1863," Mont 8vo., page XXVII., 983; "The Mineral Resources of the D Canada," Ottawa, 12mo., page 72; "Descriptive Catalogue lection of Economic Minerals of Canada at the Philadelp national Exhibition," Montreal, 1876, 8vo., page 152; "T and Minerals of New Brunswick at the Centennial Exh Philadelphia," Fredericton, N.B., 1876, by L. W. Bailey ar Jack, 12mo., page 51; "Dana's Mineralogy," 5th Edition, York, page 827; "Descriptive Catalogue of a Collecti Economic Minerals of Canada at the Colonial and Indian E London, 1886," by the Geological Corps, Alfred R. C. Selwyn London, 8vo., 1886, page 172.

The writer is indebted for information to Messrs. E. Coste Brumell, of the Canadian Geological Survey, Rev. Dr. Hon Windsor, N.S., and Mr. C. D. Nimms, the indefatigable min tor, of Philadelphia.

PYRITES AND SULPHURIC ACID.

The total production of pyrites for use in acid making in 1887 was 38,043 tons, valued at the mines at $171,194 at the average price of $4.50 a ton. Pyrites.

Compared with 1886, it is a decrease of 4863 tons, due to the fact that the force of Messrs. G. H. Nichols & Co. of the Albert Mines was not directed exclusively to extracting the ore, as they were extensively engaged during the year in building sulphuric acid works as well as a new crushing and concentrating plant, new shaft houses, new skip roads, etc.

The whole of the pyrites produced in 1887, which was as in the previous years mined at Capelton, Que., was exported to the United States. The following table (A) shews that the growth of this export from 1881 to 1886 was very rapid, and that Canadian pyrites have always been in great favor in the United States, where they form nearly 43 per cent. of all that is used; it also shows that the great industry of acid making from pyrites, which in Great Britain now consumes about 600,000 tons of pyrites yearly, is rapidly increasing in the United States, and it is evident that the result cannot fail to be a great development of Canadian pyrites mines, as there are many other deposits of the same class of ore, as at Capelton, known in the Eastern Townships. Exports.

EXPORTS OF CANADIAN PYRITES TO THE UNITED STATES, AND CONSUMPTION OF PYRITES IN THE UNITED STATES, FROM 1881 TO 1886.

TABLE A.

YEAR.	Exports from Canada to United States. Fiscal Years.	Consumed in United States. Calendar Years.
	Tons.	Tons.
1881	10,812	7,840
1882	23,980	32,368
1883	25,211	50,400
1884	26,000	72,800
1885	34,123	102,368
1886	47,410	125,440
Total	167,536	391,216

Proportion of Canadian Exports to total consumption in the United States for the six years, 43 per cent.

Imports. About 2000 tons of pyrites were imported in 1887 for
from the United States.

Sulphuric acid. The total quantity of sulphuric acid manufactured in Ca
was about 5,477,950 lbs., valued at theworks at about $70,6

The quantity made in 1886 has not been ascertained ex
it estimated that there was an increase in 1887 of about
This increase is likely to become larger this year on acc
new Capelton chemical works started at the close of 1887.

Imports.

IMPORTS OF SULPHURIC ACID.

TABLE 1.

PROVINCE.	1886.		1887.	
	Pounds.	Value.	Pounds.	V
Ontario	55,743	$733	1,658,860	$
Quebec	82,754	951	725,749	
Nova Scotia	68,373	857	186,451	
New Brunswick	139,644	1,589	138,264	
Prince Edward Island	2,045	24	....	...
Manitoba	194	4	197	
British Columbia	15,678	531	21,402	
Total	364,431	$4,689	2,730,923	$

Great increase in consumption. The above table shows the imports in 1887 to have be
eight and nine times greater than in 1886 and, as above
increase in the home production of acid was about 50 per ce
facts prove a very much larger consumption of sulphuric
in Canada; and, as this acid is the basis of all chemical in
may be taken as a sure sign of a very brisk start in the d
of these industries.

IMPORTS OF BRIMSTONE OR CRUDE SULPHUR.

TABLE 2.

Province	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	2,225,698	$24,046	1,097,882	$13,279
Quebec	626,005	9,797	776,237	11,698
Nova Scotia...........	170,571	2,641	371,625	5,566
New Brunswick........	34,513	702	58,287	936
Prince Edward Island..	929	20	1,752	36
Manitoba...............	370	11	941	27
British Columbia......	5,393	179	1,818	74
Total........	3,063,379	$37,396	2,308,542	$31,616

PYRITES DEPOSITS IN CANADA.

Quantity of Canadian pyrites used in the United States.

We have in Canada very important deposits of cupreous pyrites, in the Eastern Townships of Quebec. As shown by the statistical Table A. of page 81, these pyrites, from Capelton, P.Q., supplied, from 1881 to 1886 inclusive, 43 per cent of all that was used in the United States, notwithstanding that the transportation and duty charges from Canada to Brooklyn and New Jersey, where they are first treated, amounts to about $5.00 per ton. This shows what industrial standing Canadian pyrites has acquired in the United States, the reason being that, besides 40 per cent. of sulphur, there is also extracted from it from 3 per cent. to 4 per cent. of copper and from $3.00 to $4.00 of silver per ton. None of the American pyrites contain as much copper or silver, as may be seen by referring to the reports on the mineral resources of the United States published by the United States Geological Survey.

Comparison of the yield of Spanish and Canadian pyrites.

Comparing Canadian cupreous pyrites with those used in England, we find, according to the official "Mining and Mineral Statistics of Great Britain," that there were, during the three years, 1884, 1885 and 1886, 1,774,582 long tons of cupreous pyrites imported into Great Britain, principally from the famous Huelva district in Spain and Portugal, of a total value of £3,527,333 sterling; these, after roasting,

gave 1,217,811 long tons of burnt cupreous pyrites, which we
for copper, silver and gold, and furnished 54,450 long tons o
copper and about $1,100,000 of gold and silver. This sh
there was saved from these pyrites a copper content of abo
cent. and a value of gold and silver of less than one dollar
very much less copper and silver than what is saved from
pyrites.

A similar advantageous comparison could be made between
pyrites and the pyrites used in France and Germany, so that
said that Canadian pyrites stand to-day the best in the world

Capelton Mines

Canada can also provide very large quantities, as absolute
by the continuous production for the last ten years of many
of tons a year from one single vein on which are located the
Crown and Albert mines of Capelton. This vein is a strong
outcrops on the summit of a high flat hill for a length of a
feet in a north-east and south-west direction; it dips to the
with an angle varying from 50° to 60°. On it seven sh
been sunk: one of these (the No. 5 Hartford Mine shaft con
the Crown Mine shaft) is now about 1,600 feet deep, and an
(the Albert shaft), about 2,000 feet more to the north-east, is
850 feet deep. In both of these shafts, and in the adjoining
the vein has varied in width from two and three feet to fifty
feet of massive pyrites, and immense stopes of great heigh
seen there. The vein in shape is a succession of large,
bodies of pyrites dipping in the vein to the north-east; it foll
nearly the direction of the Archæan hydro-mica schists in w
found and with which it was contorted, disturbed and faulted
formation. Its character as a vein is nevertheless well es
by the way it often splits up into several branches across th
from the seams running in the walls from the main vein an
gangues and minerals it contains, viz., quartz, iron pyrite
pyrites, mispickel and tetrahedrite. Dykes of diorite, wi
eruptions the deposition of the pyrites may have been conn
to be seen in several places along the outcrop of the vein on
the hill, and also all through the hill; this diorite has of
encountered in the workings forming the walls or right in
as in No. 5 Hartford shaft between the 40 and 50 fathoms
the east of the shaft, and also in other places. Several slides
with an east and west direction and a north-westerly dip,
encountered in the shafts, throwing the downward portion of
up. Several dykes of columnar trap, of about the same di
the vein and nearly vertical, have also been found to cut it,
throw it.

This vein is now actively worked by the owners of the Crown and Albert mines, who employ there about 300 men. As already mentioned, page 81, sulphuric acid works and a new large mining, crushing, concentrating and transportation plant have been put up during the year 1887 by Messrs. G. H. Nichols & Co., of Brooklyn, N.Y. now the owners of the Albert, Hartford and Capel mines.

Other deposits.

Many other deposits of pyrites, very similar to the one just described, are known to exist in the Eastern Townships of Quebec, principally in the Townships of Ascot, Orford, Bolton, Sutton and Acton, and in the Counties of Megantic, Wolfe, Arthabaska and Shefford. Some of these deposits were worked extensively many years ago, but only for their copper, and the work was suspended at most of them on account of the great decline in price of that metal; but, from many of these deposits pyrites are obtainable that could be utilized also for acid-making and for the silver and gold they contain. Like those of Capelton we have no doubt that they would find a ready market not only in the United States but also in Great Britain, France or Germany where we are sure they could be made to supersede in a great measure the famous Spanish or Portuguese pyrites on account of their greater copper and precious metal contents, and of their easy burning for acid.

Other large deposits of pyrites are known in Canada, especially in Leeds, Lanark and Hastings Counties, and at Sudbury, Ont., and often contain nickel and cobalt. One of them, at Elizabethtown near Brockville, Ont., was worked for several years and furnished the sulphur to the Brockville Chemical Works. The pyrites in the Sudbury deposits, now being worked for the last two years, are unfortunately cupreous pyrrhotite or a mixture of magnetic iron pyrites and of copper pyrites, and are of very little use for acid-making, but they may be for their nickel and copper contents. The other Ontario deposits of the counties mentioned above are not cupreous, and their value, being thus consequently reduced to a minimum, is too small to permit of their being transported to the large manufacturing centres.

SALT.

The total marketed production of salt in 1887, according returns very willingly sent to this office by the producers, wa tons, or 429,807 bbls. of 280 lbs., the value of which at the w $166,394; this is the value of the salt alone; the value of the the packages used was about $241,605. The average price fo alone is thus shown to have been $2.76 per ton, or 38c. per 280 lbs.; this high average price is due to the fact that three the producers obtain much higher prices than the other manuf the average price of whose production varies between $2.00 per ton.

There were in 1887 seventeen producers in Ontario and one Brunswick, and they employed about 273 men. Compared preceding year the marketed production shows a decrease i 2,186 tons, but an increase in the value of $6,012 for the s exclusive of packages.

The following table of the yearly shipments of salt by th Trunk Railway shows that they have not varied much since 1

SALT SHIPPED BY RAIL—LAKE HURON DISTRICT—G.T.RY.

TABLE A.

Year.	Tons.
1883	35,981
1884	34,850
1885	39,600
1886	41 577
1887	36,311

Exports and Imports.

Tables 1, 2, 3 and 4, give the exports and imports of salt, pared with the above statement of the production, indicate consumption of salt in Canada in 1887 to have been about 148

EXPORTS OF SALT.

TABLE 1.

PROVINCE.	1886.		1887	
	Bushels.	Value.	Bushels.	Valu
Ontario	224,595	$16,816	153,475	$11,4
Nova Scotia	240	40	....	....
New Brunswick	90	25	570	[illegible]
Prince Edward Island	18	5	....	....
Total	224,943	$16,886	154,045	$11,5

IMPORTS OF COARSE SALT PAYING DUTY.

TABLE 2.

Province.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	855,000	$2,177	683,270	$2,110
Quebec	....	....	7,240	32
Nova Scotia	600	4	....	....
New Brunswick	....	....	2,260	9
British Columbia	10,336	38	72,000	368
Total	865,936	$2,219	764,770	$2,519

IMPORTS OF FINE SALT PAYING DUTY.

TABLE 3.

Province.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	688,211	$2,431	1,000,843	$ 3,349
Quebec	6,564,801	24,994	4,989,918	14,748
Nova Scotia	302,688	1,093	841,782	1,981
New Brunswick	1,800,890	6,177	1,662,300	5,110
Prince Edward Island	29,698	76	27,138	75
Manitoba	50,300	230	5,900	33
British Columbia	1,311,040	5,606	561,100	3,468
Total	10,747,628	$40,607	9,088,980	$28,764

IMPORTS OF SALT (DUTY FREE) FOR FISHERIES.

TABLE 4.

PROVINCE.	1886.		188
	Pounds.	Value.	Pounds.
Ontario	6,230,657	$ 10,159	1,668,942
Quebec	60,465,980	79,087	69,118,737
Nova Scotia	103,153,827	140,458	61,982,510
New Brunswick........	30,679,640	49,519	28,207,140
Prince Edward Island ...	7,199,160	8,165	4,578,787
Manitoba	133,168	935	252,100
British Columbia	672,000	1,458	1,038,453
Totals	208,534,432	$289,781	166,846,668

SILVER.

Summary. The total production of silver in 1887 is estimated to
$349,330; that is to say, there were about 349,330 ozs. of
tained in the silver ores and bullion shipped from Canada
year.

Comparison. Compared with 1886, it is an increase of $140,240, due
to the rich bodies of silver ore struck at the Beaver Mine, P
District, in the month of March, 1887. Three of the other m
By districts. Port Arthur District—the Silver Mountain, Rabbit Mountain
cupine Mines—also shipped small quantities of ore during
and the total shipments from the district amounted to $19
British Columbia, the Lanark Mine of Illecillewaet made it
ment in 1887; and it is estimated that about 146,898 ozs. of s
extracted from the copper pyrites shipped to the United S
the mines of Capelton, Eastern Townships, Quebec.

Exports. The following table, taken from the books of the Custom
ment, gives the exports of silver ore in 1887 from the provin
the outward shipments were made at the Customs offices :—

EXPORTS OF SILVER ORE.

TABLE I

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	20½	$16,505	234	$184,763
Quebec	17½	8,000	?	450
Manitoba	11	1,452	½	3,741
British Columbia	....	......	237	17,331
Totals	......	$25,957	......	$206,284

THE MOST IMPORTANT NEW DEVELOPMENTS IN THE PORT ARTHUR SILVER DISTRICT IN 1887.

The year 1887 was a very successful year for the silver district south-west of Port Arthur, and, as shown by the statistics, the production of silver in that district has been very much greater than that of the last eight or nine years. The strike of a large body of very rich ore at the Beaver Mine, in the month of March of that year, proved that the famous Silver Islet was not the only rich mine in that district; a fact already known to many but which was none the less more forcibly established and more widely recognized when the wonderful reports of richness from the Beaver Mine were duly authenticated. The interest prospectors and capitalists took already in that region, not only on account of the old mines but also of the more recent discoveries in the Rabbit Mountain and Silver Mountain districts, was at once very much increased; very great activity was soon noticed at Port Arthur and throughout the whole district and lasted during the remainder of the year. The last steps were also taken in 1887 to provide for the construction of a railway through these new silver districts; the surveys were completed, and all financial and other arrangements concluded, so as to start the work early in the following year.

Date of examination and mines working.

Our examinations in the district were made at the end of July and the beginning of August. The mines † then in active work were the Jarvis Island Mine, the Beaver Mine, the Rabbit Mountain Mine, the Badger Mine, and the Silver Mountain Mine; there was besides a

† See map accompanying Mr. Ingall's report—Part H, annual report 1886—for location of these mines.

great deal of exploratory work being done all through the re
openings were being made at some of the new locations show
encouraging and good veins containing rich ores. After e
all the working mines, except the Jarvis Island Mine,
witnessed very promising developments at some of them,
convinced of the truth of the reports of the very rich strik
Beaver Mine. In the following notes the most important facts
at the principal mines are summarised.

Beaver Mine underground developments

Beaver Mine.—At the Beaver Mine the underground dev
work was found to consist of:—†two shafts Nos. 1 and 2, res
135 and 108 feet deep, and of three levels drifted in the
opening a total length on the vein of about 770 feet. The
besides, other developments made in search of the veins c
of:—a gallery about 400 feet long drifted in the foot wall of
a cross-cut about 330 feet long, and a winze about 125 feet d
from the cross-cut.

Bodies of ore and value of the ore

The large ore body ‡ was first struck between No. 1 and
the three levels, and was found to extend in the adit level as
(the vein is about N.W.—S.E. and dips to the S.W.) as No. 2 sh
the richest ore was towards its western limits, where, in the
No. 2 levels and in stope D, there had been obtained at the tim
visit, besides the mill rock, about 100 tons of selected ore, of an
assay value of $1,500, some assays going as high as $15,000 to
The mill rock so far had averaged about $40 to the ton, and du
stay in the district its average assay value varied between
$80. Besides this large body of rich ore, several smaller ones
encountered at other places in the mine, in stopes A, B, and
on the vertical section referred to in note on page 89. As

Thickness of the vein and description. Adit level.

noticed by studying the plan and section above referred to,
level enters the hill in the hanging wall of the vein, and only
the vein a little before the stope C, where good ore was fo
where there was a good massive vein of about 3 feet; the v
suddenly pinched out and entirely disappeared it may be sa
distance of about 240 feet from the stope C to the south e
black slates composing the walls are locally disturbed there
evidently filled that part of the fissure; the vein suddenly
again and remained well open with a varying width of vein
from 2′ to 4′ 6″ as far as shaft No. 2 on that level; there,
above, the richest ore was found especially in the first 90 fee

† See plate VIII of plans and sections—Part H. annual report, 1886.

‡ The line showing its western limit on the vertical section referred to in note
is a little too near shaft No. 1, especially at the No. 2 level, where it should be brou
the right or south-east about 40 feet.

to shaft No. 1. The following is a section taken across the vein in the "Bonanza" at about 200 feet north-west from shaft No. 2.

Hanging Wall—Black Shales.

1′ to 1′ 6″ of very rich ore.	Composed of a first streak on the hanging wall of amethyst quartz, then another of white calcite with dark blende and galena, then another of white calcite with native silver and argentite.
About 2′	Of a decomposed soft slate with little stringers of white calcite through it.
3′ 0″ of mill rock.	Composed of quartz, calcite, blende, pyrites, argentite, and native silver.

Foot Wall—Black Shales.

To the south-east of shaft No. 2 in the adit level, the vein is split into two small veins of about 1 foot each by a "horse" of shales 4′ or 5′ wide.

In No. 2 level a corresponding dead ground to the one in the adit level below exists between stopes B and D; the shales there dip strongly to the south west, filling the old fissure of the vein; after that the vein opens in good ore and at the S.E. face was 2′ 6″ massive with quartz on both walls and calcite in the middle, the minerals being distributed in both gangue stones. No. 2 level.

In No. 1 level the vein was strong and well defined in the whole ground opened, varying between 2′ and 4′ 6″ massive veinstone and ore; in the part of the level through the rich ore body there was always also some soft decomposed slates sometimes in the vein and other times either on the foot or the hanging wall; outside of the ore bodies and in the poor ground the veinstones, calcite and quartz, are coarsely crystallised. No. 1 level.

Apart from the gangues already mentioned in the section given above, there was often to be found all through the ore, and principally where it was the richest, a great deal of a very white, soft, unctuous silicate of magnesia, and often some fluor-spar; besides the native silver, argentite, dark colored blende, galena and yellow pyrites already mentioned, there was also noticed in the vein some other minerals such as brittle silver and pyrrhotite. The argentite was often noticed as a pseudomorph of crystals of quartz or calcite, indicating for the silver a subsequent deposition to the gangues in the solid state. Other veinstones and minerals in vein.

The mill was not quite completed, but was already a substantial one, capable of crushing between 30 and 45 tons a day. It is situated at the end of a tramway at a little more than 2,000 feet from the mine, and on the banks of Silver Creek. The principal machinery was:— Mill and outside developments.

CRUSHING PLANT :—

One large Blake crusher (capacity 10 tons per hour) for the rock.

One small Dodge crusher (capacity 1½ tons per hour) for sam and crushing the selected ore.

One double Worthington pump 10 x 12 (capacity 12,000 gall hour.)

Two batteries of 5 stamps, fed automatically, 850 lbs. head, strokes per minute, 6 in. drop.

CONCENTRATING PLANT :—

Four Frue vanners.

One Goldengate concentrator, with a Sturtevart aspirator No.

One Krauss concentrator.

AMALGAMATING PLANT :—

Two 5 feet pans.

One 7 feet settler with a canvas filter, an amalgam safe and a s settler to clean the amalgam.

STEAM PLANT :—

One cylinder engine 22 x 24 of 150 horse-power, with a 7 ton wheel 12 feet in diameter, and a Northey feed pump.

Two 60 inches boilers 16' long with a 30 inches mud drum, inches water drum 15 feet feet long, 1 steam dome 9 feet x 3 ches, 1 copper flue heater 9 feet x 30 inches, and a 4 feet sm stack 75 feet high.

The putting up of ten more stamps, four more pans and tw settlers was being proceeded with, as well as the construc another assay office and of a furnace to evaporate the mercur the amalgam.

The mining machinery consisted of a two-flue boiler 20 feet b nishing steam to a Burleigh air compressor No. 4, of a capa seven No. 2 Rand drills, with an air receiver of 20 feet x 4 fee 6 inches air pipe; this gave the compressed air to the drills, Copeland and Bacon hoisting engine, 6-in. cylinder, on No. 2 Other necessary surface plant and houses such as saw-mill, r repair shop, blacksmith shop, boarding-houses, office, store, etc also partially built or being completed; when the mine w worked in 1885, the place was a perfect wilderness in the woo everything had been provided for and built since.

Rabbit Mountain underground developments.

Rabbit Mountain Mine.—The developments at this mine duri year 1887, were small and brought about nothing new. One sha No. 2*, had been sunk below the first level (the 80-feet leve was, at the end of July 1887, about 270 feet deep, and from tha 3 levels, below the 80-feet level, had opened only about 180

* See Plate VII. part B. annual report, 1886.

ground on the vein, viz.: about 115 feet to the N.E. of the shaft on the second level and about 65 feet to the S. W. of the shaft on the third level; so that it will be seen that the explorations below the 80 feet level are very small yet and cannot consequently prove or indicate much. No. 1 level or the 80 feet level was about 370 feet long. There was besides some work done on what appears to be a branch of the main vein outcropping about 100 feet to the N. W.; the extent of that work can be seen by reference to Plate VII. above mentioned.

Good ore containing a good deal of argentite was found:—in stopes C. D. and E., in shaft No. 2 just below the No. 2 level, in the sump of that level, also in No. 4 level southwest and in the bottom of the shaft just below that level. Situation of bodies of ore.

The section at the face of No. 4 level was:— Size and description of vein. No. 4 level.

Hanging wall—black shales.
About 1′ 6″ of quartz and calcite.
About 2′ of slickensided slates often impregnated with argentite.
About 1′ of good ore composed of galena, light colored blende and argentite in calcite.
Foot wall—black shales, smooth, well separated from vein matter.

The northeast face of that level was entering a dead ground in the vein already met in No. 3 and No. 2 levels, about 70 feet N.E. from the shaft, and there was only at that face 6″ of vein matter along a good foot wall. At the faces S.W. of No. 3 and No. 2 level the vein was about 4 feet wide, massive, composed of a poor ore almost wholly made up of large crystals of calcite and quartz. No. 3 and No. 2 levels.

Between No. 2 and No. 1 level in the shaft the vein pinches out and is very small, when it re-opens again to from 2 to 4 feet of a well banded vein of coarse calcite and quartz in No. 1 level. In stopes C. D. and E. very rich nuggets of argentite were obtained. Some 500 feet S. W. of No. 2 shaft an opening shows the vein to be about 5 feet, strong and massive and to be composed of calcite with a little fluor spar, blende and galena. Shaft. No. 1 level. Outcrop.

The vein, apart from the gangues and minerals mentioned above, was also noticed to contain some fluor spar, baryta and iron pyrites.

The mill consisted of a small Blake crusher, 5 stamps, 2 Frue vanners, 4 settling tanks, 2 pans, one settler, one small settler for cleaning the amalgam, one amalgam safe and one engine and boiler. Mill and hoisting machinery.

At the time of our visit a new large two cylinder hoisting engine had just been received from the Iron Bay Manufacturing Co., Marquette, Mich., and preparations were being made to replace by it the old small hoisting engine in use so far.

Badger Mine.—The developments at this mine were very
very promising indeed, showing, as they did, rich ore and a
They consisted of a cut through about 120 feet of boulder
of a tunnel at the end of that cut running in the vein through
slates just under a trap hill. This tunnel, at the time of our
only about 25 or 30 feet long, and showed at the face a vei
feet wide: 1' 6" of calcite on the foot and about 6" of qua
hanging wall. In the trap just above the tunnel the quartz a
were separated into two well defined small veins. The direc
vein in the tunnel is 36° east of north magnetic, and its di
to be S. E., but it was nearly vertical as far down as the t
could not be clearly detected. The minerals and gangues o
the vein were native silver, argentite, galena, dark colore
fluor spar, quartz and calcite; native silver and argentite
seen in the quartz, the galena and blende were observe
gangues. The slates at the hanging-wall at the entrance of t
were impregnated with blende, galena and argentite.

There were no surface developments of any account, but
stand that a mill has since been built.

Porcupine Mine.—Work had been suspended at this mine
I understand, soon to be started again.

The underground work consisted of 4 short levels and one
the west side of the hill and of a small shaft, 60 feet deep, o
side of the hill, some 600 feet from the centre of the other w

The mean direction of the vein is about 70° east of magne
and it dips a little to the south, but is almost vertical; its wi
between one foot and three feet, and considerable argentite
glance has been obtained, and can be seen in the roof and fac
four levels driven in the slate. The slates are often impregn
it. Through the trap in the shaft there was no silver in the
there was a little galena and blende. A little native silver
been obtained, and the gangues are exactly the same as at t
mines, viz., calcite, quartz and fluor spar; argentite has
observed there as pseudomorphs after quartz. As the shaft w
water, I could not ascertain if silver was found at the bottom
enters the slates, but I believe some was found, as I was infor

No machinery or outside developments of any consequence

Silver Mountain Mine.—Work had been pushed with
this mine, and quite a little underground development done a
of July 1887, consisting of three shafts, each about 120 feet d

See Plate VII, Part H., annual report, 1886.

levels each about 600 feet long, two winzes and several pits; the adit level is about 200 feet below the mouth of the shafts, and No. 3 shaft is about 820 feet west of No. 2 shaft.†

The vein cuts across Silver Mountain in an east and west direction (or, more properly, about 72° east of magnetic north is the mean direction of the vein between No. 1 shaft and No. 3 shaft, but it curves to the north between No. 1 shaft and No. 3 pit), dips north, and occupies a well-marked line of fault, with a downthrow of the hanging wall of about seventy feet, as evidenced by the junction of the trap and slates being found on the hanging wall of the vein in No. 1 and No. 2 shafts at ninety feet from the surface instead of twenty feet as on the foot wall.

Rich ore was found in several small bunches at different places in the eastern part of the mine and generally along the foot wall:—in No. 4 pit and in the drift below from that pit, in the two stopes above No. 2 level, and in No. 2 shaft at about sixty-five feet down. Good ore (pieces of which assayed $90 to the ton) was also found in No. 3 shaft at the depth of about seventy feet. Bodies of rich ore.

The vein is a long one, and of good width as a rule, notwithstanding that the thickness is very variable and almost nothing in some places. In No. 2 level, in nearly the whole of the ground opened, there is a total width of about five or six feet of veinstone, generally separated into several seams as at the west face of that level where the following section was obtained from the hanging to the foot wall:— Size of the vein. No. 2 level.

1′ 6″ of quartz, calcite and fluor-spar.
2′ of slates.
2′ of quartz, calcite and fluor-spar.
1′ 6″ of slates.
3′ of fractured slates, all impregnated with vein matter.

In No. 2 shaft, the width all the way down varied between three and six feet; and in No. 3 shaft it was seven feet wide at the start, a few inches only at sixty-five or seventy feet down, and about two feet six inches again at the bottom, 120 feet. No. 1 drift is in dead ground all the way, that is to say, the fissure is almost completely filled up with slates, except about sixty feet around the first winze sunk below the adit, where there is a very brecciated vein of about two feet, and except the last fifteen feet near the face where there was about one foot of brecciated vein. No. 2 shaft. No. 3 shaft. No. 1 level or adit level.

The gangues forming the vein are calcite, quartz (white and amethystine) and fluor spar. The following minerals are disseminated through these veinstones:—light-colored blende, galena, iron pyrites, argentite and native silver. Composition of the vein.

† See Plate IX., Part H., Annual Report, 1886.

Mining plant.

No mill had yet been put up at the Silver Mountain Mine mining plant consisted of the following machinery, viz. :— air compressor, capable of running three No. 1, Rand drills, a tubular boiler of thirty horse-power, and one hoisting eng 12-inch cylinders, with a 4 feet drum, fed by a twenty ho tubular boiler, on No. 3 shaft.

Other veins discovered and worked a few years ago.

A great many other veins of precisely the same nature covered all through that district; they contain exactly minerals and veinstones, and are exactly in the same geologi tions, that is :—they cut through the cherts, black slates an an horizontal series, the Animikie, resting unconformab Archæan rocks. Some of these veins were a little work many places rich ores were obtained, as we had occasion to ourselves at some of them. It is unnecessary here to men all as their progress will be followed when they bec developed.

New discoveries last year

Numerous and important new discoveries were made also summer of 1887, and have further extended the area of Anim in which silver-bearing veins were already actually known We have ascertained this to be a fact by going ourselves to (five or six miles west of Whitefish Lake, and about two m of the east end of Arrow Lake) and there we saw that good taining rich black blende and some argentite, had been fou different veins, and also that some native silver had been o one of them; the veins were several feet wide and in exact geological and other conditions as those described above.

Conclusion.

We think that every one will now admit what we have s beginning of this article, viz:—that the year 1887 was a ver ful one for the Port Arthur Silver district; and, to conclude will say that the recent developments in that region, princi of 1887, have again brought it forward before the eyes of t as it was at the time of the discovery and of the working of Islet and the other old mines, as a region containing a grea of very well defined veins containing very rich silver ores; a body understands now that it only needs, no doubt in ma active work and the help of capital to develop these veins mines. We know also now that these veins will be found al the area occupied by the Animikie rocks, which the res Messrs. Ingall and Lawson, of the Geological Survey, hav to extend as far west as Gun-Flint Lake, and to occupy al square miles, the greater part of which is still unexplored.

STRUCTURAL MATERIALS.

Granite.—The total production in 1887 as reported directly to this office, was 21,217 tons, valued in the rough state at the quarries at $142,506. It is an enormous increase over 1886 of 145 per cent. in the three provinces of Ontario, Quebec, and New Brunswick; we cannot say as to Nova Scotia as we had not the figures for that province last year; this increase speaks for itself, and demonstrates how much the granites from Kingston and from St. George, N.B., which are worth from $10.00 to $18.00 per ton at the quarries, are becoming appreciated. Granite.

The production by provinces was as follows:— Production by provinces.

Ontario	7,663 tons.	$ 73,800
New Brunswick	6,681 "	48,281
Nova Scotia	6,289 "	15,125
Quebec	584 "	5,300
Total	21,217 tons.	$142,506

In New Brunswick, besides the very valuable granite from St. George, (worth about $1.00 per cubic foot in the rough state) there was also a large quantity of gray granite quarried at Hampstead, Queen's Co., for structural purposes, and of less value.

A good deal of Canadian granite is polished and manufactured for ornamental and monumental purposes in the country. The exact quantity thus manufactured and marketed during the year could not be ascertained but is estimated to have been about 3,500 tons, sold for about $350,000. Manufactured article.

Marble and Serpentine.—The production, as far as returned from three quarries, was 242 tons valued, in the rough state but quarried to sizes, at about $6,224. This is not a complete statement of the total production. Marble and serpentine.

The value of the imports of marble, and manufactures of stone or granite N.E.S. (as classified in the returns of the Customs Department) will be found in the following tables 1 and 2:— Imports.

TABLE 1

Provinces.	[illegible]	[illegible]	[illegible]	[illegible]
Ontario	[illegible]	[illegible]	[illegible]	[illegible]
Quebec	414	21,073	1,581	21,2
Nova Scotia	736	5,637	2,060	7,0
New Brunswick	737	6,420	308	6,3
Prince Edward Island		2,683	106	1,8
Manitoba	12	78		
British Columbia		1,147	226	1,8
Total	$3,778	$81,368	$6,484	$76,47

TABLE 2.

Manufactures of Stone or Granite, N.E.S.	1886.	1887.
Ontario	$33,695	$15,353
Quebec	[illegible]	[illegible]
Nova Scotia	1,037	451
New Brunswick	1,053	40
Prince Edward Island	[illegible]	[illegible]
Manitoba	373	1,059
British Columbia	1,052	940
Total	$41,083	$21,611

Slate.

Slate.—The production of slate in 1887 was 7,357 tons whic valued manufactured at the quarries at $89,000 ; it is an incre 1886 of a little more than 2,000 tons and was also all quarried province of Quebec.

7

Flagstone.—The returns of flagstone received amount to a production of 116,000 square feet with a value at the quarries of about $11,600; the great bulk of this is from Dudswell, Quebec. Flagstone.

The tables of exports and imports of slate and flagstone are appended. Exports and imports.

EXPORTS OF SLATE FOR LAST FOUR YEARS.

TABLE 3.

Year.	Quebec. Tons.	Quebec. Value.	Nova Scotia. Tons.	Nova Scotia. Value
[illegible]	939	$5,845		
1885	346	5,274		
1886	[illegible]	[illegible]		
1887	27	373	22	$660

IMPORTS OF SLATE.

TABLE 4.

Province.	1886.	1887.
Ontario	$16,253	$17,299
Quebec	8,071	2,211
Nova Scotia	1,438	927
New Brunswick	3,130	3,909
Prince Edward Island	182	88
Manitoba	329	191
British Columbia	289	589
Total	$29,692	$25,214

IMPORTS OF DRESSED FLAGSTONES.
TABLE 5.

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons	Value.
Ontario	1,494	$11,513	2,531	$2[illegible],233
New Brunswick	......	......	1	36
	1,494	$11,513	2,532	$20.269

Building stone.

Building Stone.—We have received many more returns this year, number being 129 instead of 94 received last year; and the recorde duction of 1887 is nearly 100,000 cubic yards more than what w turned in 1886. This simply demonstrates that the 1886 returns of ing stones were unfortunately very incomplete owing to the shor then available for collecting addresses of the producers; the valu was over-stated in the returns, and included probably a great d freight costs. Though the returns for 1887 are much improved, are still incomplete, and every producer is earnestly requested to in his address before the end of the year, and thus render poss complete record for 1888.

PRODUCTION OF BUILDING STONE IN 1887

As returned to this office, and estimated to be three to four-fifths of the total production.

TABLE 6.

PROVINCE.	No. of Returns.	Cubic Yards.	Value
Ontario	70	184,426	$343,046
Quebec	16	41,251	72,958
Nova Scotia............	About 25	22,328	68,682
New Brunswick.........	8	6,871	52,901
Prince Edward Island....	4	1,536	2,700
Manitoba................	3	3,052	5,050
British Columbia.........	1	1,00[illegible]	1,500
North-West Territories..	2	2,128	5,430
Total	About 129	262,592	$552,267

The following exports and imports tables of stone are given as classified by the Customs Department; the marble could not be separated from other stones.

Exports and imports.

VALUE OF EXPORTS OF STONE AND MARBLE, WROUGHT AND UNWROUGHT.

TABLE 7.

Province.	1886.		1887.	
	Wrought.	Unwrought.	Wrought.	Unwrought.
Ontario	$ 103	$27,922	$ 17	$ 4,490
Quebec..... ...	1,206	......	670	......
Nova Scotia.....	121	18,377	425	24,476
New Brunswick..	18,596	26,954	12,827	24,925
British Columbia.	.....	......	70	95
Total	$20,026	$73,253	$14,049	$53 986

IMPORTS OF DRESSED FREESTONE AND ALL OTHER BUILDING STONE.

TABLE 8.

Province.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	777	$5,108	7	$3,189
Quebec	5	185	11	74
New Brunswick.....	2	10	....	....
Prince Edward Island	....	....	....	2
British Columbia ...	....	....	240	148
Totals	784	$5,303	....	$3,413

IMPORTS OF ROUGH FREESTONE, SANDSTONE AND BUILDING STONE

Provinces.	1886		1887	
	Tons	Value	Tons	Value
Ontario	7,499	$39,282	6,384	$47,61[illegible]
Quebec	202	1,909	2,649	22,01[illegible]
New Brunswick	25	453	25	25[illegible]
Totals	7,726	$41,644	9,058	$69,87[illegible]

Lime. *Lime.*—The same remarks that were made for the buildi[ng]
apply to the lime returns; 133 returns were received inste[ad]
last year, and the value is $100,000 more than the total valu[e]
at last year. About four-fifths of the total production is now s[upposed]
to have been returned.

Cement. *Cement.*—The compilation of seven returns received from
works gives the following result which is believed to be ver[y]
a complete record:—69,843 bbls., valued at the works at $81,[illegible]

PRODUCTION OF LIME IN 1887, AS RETURNED TO THIS OFFICE.

TABLE 10.

Provinces.	No of returns.	Bushels.	Value.
Ontario	78	1,239,451	$178,153
Quebec	21	424,316	79,137
Nova Scotia	10	49,400	11,448
New Brunswick	13	478,410	102,463
Prince Edward Island.	3	30,280	8,814
Manitoba	5	32,600	8,500
British Columbia.....	1	10,080	2 688
North-West Territories	2	4,360	3,262
Totals...........	133	2,269 087	$394 859

EXPORTS OF LIME AND CEMENT.

TABLE 11.

Provinces.	Value.
Ontario	$4,269
Quebec	83
Nova Scotia	142
New Brunswick	77,518
Manitoba	4
British Columbia	241
Prince Edward Island	4
Total	$82,261

IMPORTS OF LIME AND CEMENT FOR THE YEAR 1887.

TABLE 12.

Province.	Bbls.	Value.
Ontario	4,379	$3,487
Quebec	3,441	2,501
Nova Scotia	450	407
New Brunswick	66	44
Manitoba	904	791
British Columbia	700	860
Total	9,920	$8,090

IMPORTS OF HYDRAULIC CEMENT.

TABLE 13.

Province.	1886.		1887.	
	Bbls.	Value.	Bbls.	Value.
Ontario............	3,553	$3,408	3,505	$3,705
Quebec	1,414	2,119	46	163
Nova Scotia	9	15	31	70
New Brunswick......	1,576	1,840	1,476	2,054
Prince Edward Island	25	31	....	....
British Columbia....	564	1,896	35	136
Total........	7,141	$9,309	5,093	$6,126

IMPORTS OF CEMENT IN BULK OR IN BAGS.

TABLE 14.

Province.	1886.		1887.	
	Bushels.	Value.	Bushels.	Value.
Ontario	4,520	$1,134	6,029	$1,554
Quebec	918	470	....	....
Nova Scotia	....	....	18,666	4,456
Total........	5,438	$1,604	24,695	$6,010

IMPORTS OF PORTLAND CEMENT.

TABLE 15.

Province.	1886.		1887.	
	Bbls.	Value.	Bbls.	Value.
Ontario	....	$ 5,049	5,705	$ 7,761
Quebec	....	131,238	98,760	139,409
Nova Scotia	....	5,900	6,911	11,124
New Brunswick	....	2,999	2,846	4,307
Prince Edward Island	....	290	123	186
Manitoba	....	3	....	....
British Columbia	....	3,358	2,515	6,682
Total	....	$148,837	116,860	$169,469

Sand and Gravel.—The exports and imports alone have been ascertained through the Customs returns. Sand and Gravel.

EXPORTS OF SAND AND GRAVEL.

TABLE 15.

Province.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	124,662	$23,902	180,699	$29,470
Quebec	....	....	....	22
Nova Scotia	200	200	161	815
New Brunswick	3	124	....	....
Total	124,865	$24,226	180,860	$30,307

IMPORTS OF SAND AND GRAVEL.

TABLE 16.

Province.	1886.		1887.	
	Tons.	Value.	Tons.	Va
Ontario	11,298	$15,002	10,361	[illegible]
Quebec	5,794	6 191	6,586	[illegible]
Nova Scotia	1,307	4,015	1,264	[illegible]
New Brunswick	906	1,120	1,014	[illegible]
Manitoba	30	83	15	[illegible]
British Columbia	27	45	1	[illegible]
Total	19,362	$26,456	19,241	$30

Bricks and Tiles.

Bricks and Tiles.—The same remarks as above for buildi and lime apply here also; 26 more returns were received this bricks and 13 for tiles, and the proportion of the returns to production is now believed to be about three-fourths.

Miscellaneous clay products.

Fifteen returns were also received of $182,150 worth of misce clay products manufactured in 1887, such as glazed sewe pottery, ornamental bricks, fire bricks, bath bricks, pressed stone and carbonized drain tiles.

PRODUCTION OF BRICKS DURING 1887, AS RETURNED TO THIS OFFICE

TABLE 17.

Province.	No. of Returns.	Thousands.	Value.
Ontario	222	149,821	$778,757
Quebec	[illegible]	13,820	80,117
Nova Scotia	15	6,981	43,311
New Brunswick	[illegible]	6,476	43,154
Prince Edward Island	6	1,328	9,165
Manitoba	[illegible]	835	8,125
British Columbia	2	3,020	19,480
North-West Territories	2	300	4,300
Total	287	181,581	$986,689

PRODUCTION OF TILES DURING 1887, AS RETURNED TO THIS OFFICE.

TABLE 18.

PROVINCE.	No. of Returns.	Thousands.	Value.
Ontario	88	14,450	$226,546
Nova Scotia	2	45	435
New Brunswick	5	157	3,087
Total	95	14,655	$230,068

IMPORTS OF BUILDING BRICK.

TABLE 19.

PROVINCE.	1886.		1887.	
	Thousands.	Value.	Thousands.	Value
Ontario	213	$1,269	173	$1,861
Quebec	119	1,133	1,620	13,444
Nova Scotia	2	11	......	82
New Brunswick	13	59	......	64
Prince Edward Island	3	57	......	[illegible]
Manitoba	......	......	......	[illegible]
British Columbia	......	......	185	[illegible]
Total	350	$2,529	1,980	[illegible]

Imports.

IMPORTS OF DRAIN TILE AND SEWER PIPE, GLAZED.

TABLE 20.

PROVINCE.	1886.	1887.
Ontario	$45,706	$71,424
Quebec	8,510	16,041
Nova Scotia	......	554
New Brunswick.	979	914
Prince Edward Island..	16	......
Manitobа	506	809
British Columbia......	654	638
Total	$56,371	$90,380

IMPORTS OF FIRE-CLAY.

TABLE 21.

PROVINCE.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	20,750	$5,033	23,822	$7,28
Quebec	78,863	10,273	130,959	17,86
Nova Scotia..........	2,152	704	3,014	1,10
New Brunswick.......	780	84	3,675	31
Prince Edward Island..	90	27	86	9
Manitoba	240	120	240	12
British Columbia......	750	330	1,474	72
Total	103,625	$16,571	163,270	$27,44

IMPORTS OF FIRE BRICKS, TILES, ETC.

TABLE 22.

Provinces.	1886.	1887.
Ontario	$23,887	$21,221
Quebec	25,903	31,240
Nova Scotia	4,216	687
New Brunswick	6,735	7,778
Prince Edward Island	41	263
Manitoba	79	178
British Columbia	1,226	962
Total	$62,087	$62,329

IMPORTS OF CLAYS, ALL OTHER N. E. S.

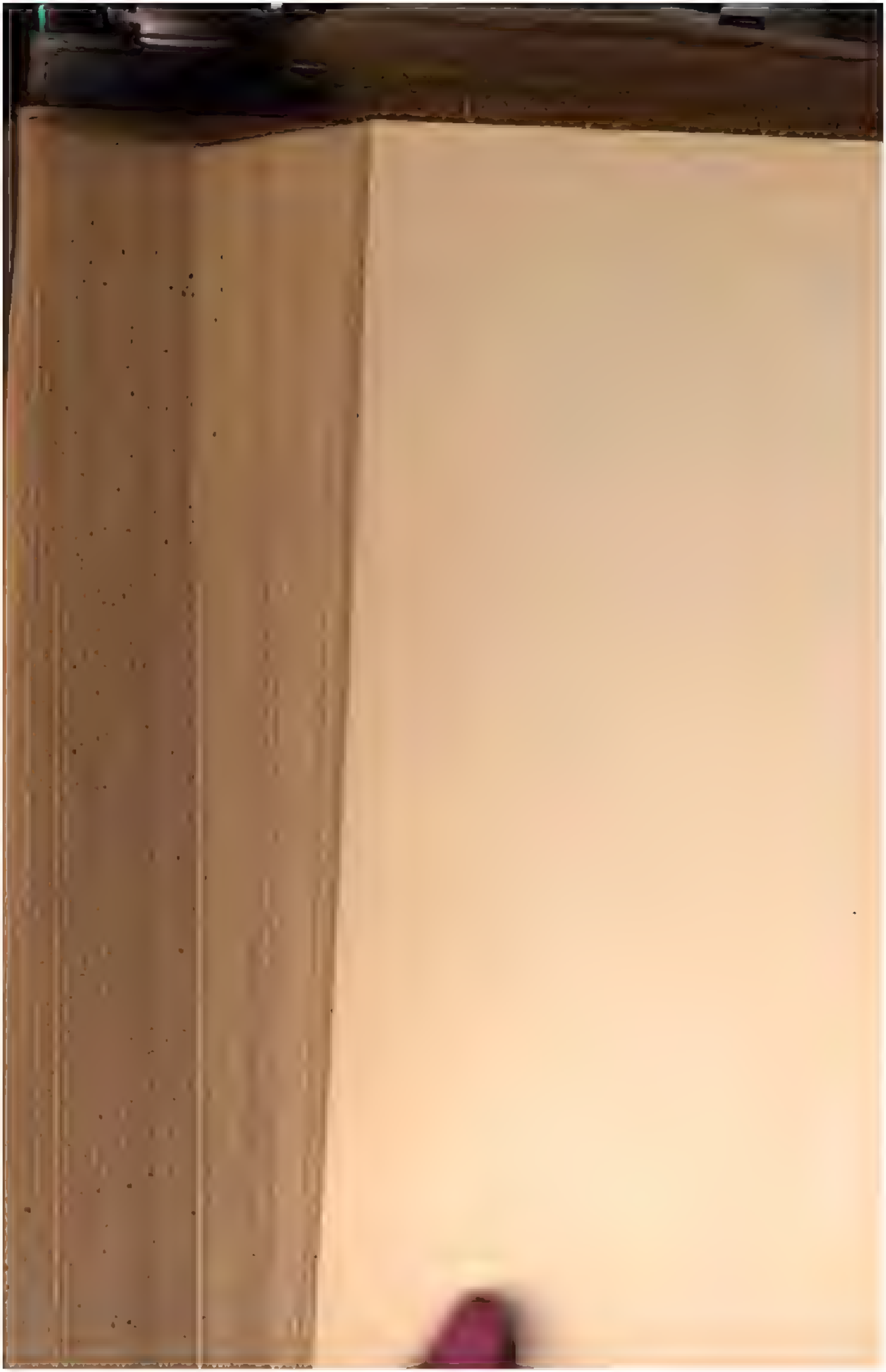
TABLE 23

Provinces.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	16,369	$3,238	15,433	$5,502
Quebec	12,787	1,553	1,245	473
New Brunswick	13,203	279	1,044	233
British Columbia	....	....	....	3
Totals	42,359	$5,070	17,722	$6,211

IMPORTS OF EARTHENWARE

TABLE 24.

ARTICLES.
Brown and colored Earthen and Stoneware and Rockingham ware
Decorated, printed or sponged, and all Earthenware, N. E. S.
Demijohns or jugs, churns and crocks
Totals



GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

CHEMICAL CONTRIBUTIONS

TO THE

GEOLOGY OF CANADA,

FROM THE

LABORATORY OF THE SURVEY,

BY

G. CHRISTIAN HOFFMANN, F. Inst. Chem., F.R.S.C.,
Chemist and Mineralogist to the Survey.

ASSISTANTS:

F. D. ADAMS, M.Ap.Sc.
E. B. KENRICK, B.A.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

To ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S.,
Director of the Geological and Natural History Survey of Canada.

SIR,—I beg to submit, herewith, my report upon the work carried out in the Laboratory of this Survey during the past year. As will be seen, this was purely of a practical character, it having been confined exclusively to the examination of such minerals, etc., etc., as promised to prove of economic importance. During the period in question, some six hundred and ninety-eight mineral specimens were received, either for identification, for information in regard to their economic value, or for analysis or assay. The results obtained were in a large number of instances of no great interest, save to those immediately concerned, and have, therefore, not been incorporated in the present report, which embraces only such examinations, analyses, or assays, as were considered likely to prove of general interest.

Mr. F. D. Adams has—with the exception of about three and a-half months during the summer, when he was engaged in field-work—in the capacity of Assistant Chemist, rendered good service, and Mr. E.B. Kenrick worked faithfully and diligently as Junior Assistant Chemist, up to the end of August, when he left to accept an appointment at St. John's College, Winnipeg. His successor, Mr. R. A. A. Johnston, has also assisted in some of the work herein recorded.

Such examinations or analyses as were carried out by these gentlemen have, in all instances, been duly credited to them: those not otherwise designated, having been made by myself.

I have the honor to be,

Sir,

Your obedient servant,

G. CHRISTIAN HOFFMANN.

OTTAWA, December 31, 1887.

CHEMICAL CONTRIBUTIONS

TO THE

GEOLOGY OF CANADA,

FROM THE

LABORATORY OF THE SURVEY.

COALS AND LIGNITES.

[In continuation of previous reports on this subject, Report of Progress, 1882-83-84,—Report M, and Annual Report, 1885, Report M.]

52.—LIGNITE.—From seam near mouth of Egg Creek, North Saskatchewan River, opposite Victoria, township 58, range 17, west of the fourth initial meridian, District of Alberta, N. W. T. Seam thirteen inches thick. Geological position—Cretaceous, Pierre. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 117 E. Lignite from Egg Creek, North Saskatchewan.

Structure, somewhat fine lamellar, tolerably compact; it contains numerous interposed patches of mineral charcoal; in parts coated with a film of ferric hydrate; color greyish-black to almost black; lustre along the surfaces of bedding dull, that of the cross-fracture sub-resinous to resinous; fracture uneven; apart from the patches of mineral charcoal, does not soil the fingers; powder dark-brown, inclining to blackish-brown; it communicates a deep brownish-red color to a boiling solution of caustic potash; by exposure to the air, splits in the direction of the bedding and falls to pieces.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	11·91
Volatile combustible matter	36·39
Fixed carbon	45·04
Ash	6·66
	100·00
Coke, per cent	51·70
Ratio of volatile combustible matter to fixed carbon	1 : 1·24

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, feebly luminous, smokeless flame. The ash has a light brownish-yellow color,—exposed to a bright red heat it becomes slightly agglutinated, at a most intense red heat it forms a slaggy mass.

Lignite from Big Island seam, North Saskatchewan.

53.—Lignite.—From the Big Island seam, North Saskatchewan River, twelve miles above Edmonton, township 51, range 25, west of the fourth initial meridian, District of Alberta, N. W. T. Seam three feet eight inches thick. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 112 E.

Structure, coarse lamellar—made up of layers of a greyish-black, dull, and dense. bright black coal, with numerous interposed patches of mineral charcoal; it was in parts stained with ferric hydrate; fracture uneven; apart from the patches of mineral charcoal, does not soil the fingers; powder brownish-black; it communicates a dark brownish-red color to a boiling solution of caustic potash; by exposure to the air becomes fissured, and as a result falls to pieces.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	8·92
Volatile combustible matter	28·70
Fixed carbon	37·44
Ash	24·94
	100·00
Coke, per cent	62·38
Ratio of volatile combustible matter to fixed carbon	1 : 1·30

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, slightly luminous, smokeless flame. The ash has a reddish-white color,—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a slaggy mass.

Lignite from Ross' seam, North Saskatchewan.

54.—Lignite.—From Ross' seam, North Saskatchewan River, right bank, one and a-half mile below ferry at Edmonton, District of Alberta, N. W. T. Seam four feet thick. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 113 E.

Structure, fine lamellar—compact; color black; lustre resinous; fracture uneven; does not soil the fingers; it was in parts coated with a slight deposit of ferric hydrate; powder dark-brown, incli-

ning to blackish-brown; it communicates a deep brownish-red color to a boling solution of caustic potash; by exposure to the air, splits along the line of bedding and falls to pieces.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	11·47
Volatile combustible matter	36·12
Fixed carbon	48·57
Ash	3·84
	100·00
Coke, per cent	52·41
Ratio of volatile combustible matter to fixed carbon	1:1·34

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, somewhat luminous, slightly smoky flame. The ash has a dull yellow color,—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it readily fuses to a vitrified mass.

55.—Lignite.—From the Red Deer River, twelve miles above Tail Creek, township 38, range 24, west of the fourth initial meridian, District of Alberta, N. W. T. Seam ten feet, with three feet of interbedded sandstone and shale. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 60 E. Lignite from Red Deer River, above Tail Creek.

Structure, somewhat fine lamellar—made up of greyish-black, dull, and bright black layers, with an occasional intervening layer of mineral charcoal; fracture uneven, occasionally, in parts verging on the conchoidal; it was, here and there, coated with a slight deposit of ferric hydrate; powder greyish-brownish-black; it communicates a deep brownish-red color to a boiling solution of caustic potash; by exposure to the air falls to pieces.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	7·66
Volatile combustible matter	25·90
Fixed carbon	34·53
Ash	31·91
	100·00
Coke, per cent	66·44
Ratio of volatile combustible matter to fixed carbon	1:1.33

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, slightly luminous, smokeless flame. The

ash has a greyish-brown color—exposed to a bright red heat it becomes slightly agglutinated, at a most intense red heat it becomes fritted.

Lignite from Red Deer River, below Tail Creek.

56.—Lignite.—From the Red Deer River, four miles below Tail Creek, township 37, range 22, west of the fourth initial meridian, District of Alberta, N. W. T. Ten and a-half feet coal in an eighteen feet section, thickest seam three feet. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 61 E.

Structure, compact; color black; lustre resinous; fracture more or less conchoidal; does not soil the fingers; powder brownish-black; it communicates a deep brownish-red coloration to a boiling solution of caustic potash; by exposure to the air falls to pieces.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	10·02
Volatile combustible matter	32·11
Fixed carbon	45·19
Ash	12·68
	100·00

Coke, per cent	57·87
Ratio of volatile combustible matter to fixed carbon	1 : 1·41

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, slightly luminous, smokeless flame. The ash has a light reddish-brown color,—exposed to a bright red heat it does not become agglutinated, at a most intense heat it forms a slaggy mass.

Lignite from Knee Hills Creek, Red Deer River.

57.—Lignite.—From seam on Knee Hills Creek (a tributary of the Red Deer River), township 29, range 23, west of the fourth initial meridian, District of Alberta, N. W. T. Seam four feet thick. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 72 E.

Structure, somewhat coarse lamellar—made up of greyish-black, dull, and bright black layers; fracture uneven; it contains, here and there, a little brownish-yellow transparent resin; does not soil the fingers; powder brownish-black; it communicates a deep brownish-red color to a boiling solution of caustic potash; by exposure to the air becomes slightly fissured, still remaining, however, tolerably firm and hence, in this regard, is superior to the generality of lignites.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	9·86
Volatile combustible matter	34·89
Fixed carbon	46·57
Ash	8·68
	100·00
Coke, per cent	55·25
Ratio of volatile combustible matter to fixed carbon	1 : 1·33

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, somewhat luminous, smokeless flame. The ash has a yellowish-brown color,—exposed to a bright red heat it does not become agglutinated, at a most intense red heat it forms a slaggy mass.

58.—Lignite.—From a seam on Meeting Creek (a tributary of Battle River), township 45, range 17, west of the fourth initial meridian, District of Alberta, N. W. T. Seam four and a-half feet thick. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 88 E. Lignite from Meeting Creek, Battle River.

Structure, fine lamellar—compact; color black; lustre resinous; fracture uneven; does not soil the fingers; powder brownish-black; it communicates a deep brownish-red color to a boiling solution of caustic potash; by exposure to the air splits in the direction of the bedding and falls to pieces.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	11·68
Volatile combustible matter	35·82
Fixed carbon	49·88
Ash	2·62
	100·00
Coke, per cent	52·50
Ratio of volatile combustible matter to fixed carbon	1 : 1·39

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, feebly luminous, smokeless flame. The ash has a reddish-brown color—exposed to a bright red heat it becomes agglutinated, at a most intense read heat it forms a slaggy mass.

59.—Lignitic Coal.—From Rocky Mountain House seam, one mile below the mouth of Clearwater River, on the North Saskatchewan

Lignitic coal from Rocky Mountain House seam, North Saskatchewan.

River, section 33, township 39, range 7, west of the fifth initial meridian, District of Alberta, N. W. T. Seam two feet or more. Geological position—Laramie. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 102 E.

Structure, compact; it is intersected by numerous thin plates of gypsum and calcite, and contains, in parts, a few films of iron-pyrites; shows well-defined planes of cleat; color black; lustre resinous; does not soil the fingers; powder brownish-black; it communicates a brownish-red color to a boiling solution of caustic potash; by exposure to the air becomes fissured, and hence somewhat tender. Another specimen from the same seam had a somewhat coarse lamellar structure, made up of layers of a greyish-black, dull, and bright black coal; this also showed well-defined planes of cleat; it contained only a few plates of calcite, and after the same length of exposure to the air as the other specimen, still remained hard and firm.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	7·01
Volatile combustible matter	34·63
Fixed carbon	50·34
Ash	8·02
	100·00
Coke, per cent	58·36
Ratio of volatile combustible matter to fixed carbon	1:1·45

It yields a non coherent coke; the gases evolved during coking burnt with a yellowish, somewhat luminous, slightly smoky flame. The ash has a dark brownish-yellow color,—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a slaggy mass.

Lignitic coal from Red Deer River, near outer edge of Foot Hills.

60.—Lignitic Coal.—From a seam on Red Deer River, near the outer edge of the Foot Hills, township 31, range 7, west of the fifth initial meridian, District of Alberta, N. W. T. Seam nine feet thick. Geological position—Laramie. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 125 E.

Structure, very fine lamellar—compact; it contains interstratified, more or less disconnected, lenticular layers of jet black lustrous coal, and numerous patches of mineral charcoal; color greyish-black to black; lustre, apart from that of the layers above referred to, resinous; fracture uneven; powder dark-brown, inclining to blackish-brown; it communicates a brownish-red color to a boiling

solution of caustic potash; it, apparently, resists exposure to the air and is, on the whole, a firm coal.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	4·97
Volatile combustible matter	36·87
Fixed carbon	54·05
Ash	4·11
	100·00
Coke, per cent	58·16
Ratio of volatile combustible matter to fixed carbon	1:1·46

It yields a non-coherent coke: the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a brownish-yellow color,—exposed to a bright red heat it does not become agglutinated, at a most intense red heat it readily fuses to a vitrified mass.

61.—Lignitic Coal—From Lewes River (a branch of the Yukon River), four and a-half miles above Rink Rapid, N.W.T. Seam about three feet, but in part shaly. Geological position—Laramie. Collected by Dr. G. M. Dawson. Lignitic coal from Lewes River.

Structure, fine lamellar—compact; color greyish-black; lustre resinous; hard and firm; fracture uneven; it is, here and there, intersected by a few films of calcite; does not soil the fingers; powder brownish-black; it communicates a dark, but not deep, brownish-red color to a boiling solution of caustic potash; resists exposure to the air.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	6·03
Volatile combustible matter	36·92
Fixed carbon	49·03
Ash	8·02
	100·00
Coke, per cent	57·05
Ratio of volatile combustible matter to fixed carbon	1:1·33

It yields a non-coherent coke. Color of the ash, brown with a faint reddish tinge, the same when exposed to a bright red heat does not agglutinate, at a most intense red heat it readily fuses to a vitrified mass.

62.—Coal—From the Bow River Coal Mine, south side of Bow River, a quarter of a mile S. 25° E. from mouth of Coal Creek, section 13,

Coal from Bow River Mine, south side of Bow River.

township 26, range 5, and section 18, township 26, range 4, west of the fourth initial Meridian, District of Alberta, N.W.T. Seam said to be ten feet ten inches, with three partings, total thickness of coal seven feet seven inches. The part of the workings from which this sample was taken is some three hundred feet from the outcrop, and about two hundred feet below the level of the prairie. From lower part of seam. Geological position—Lower Laramie. Received from Mr. J. W. Vaughan. Referred to in Annual Report for 1886, p. 122 E.

[Specimen 28—Report of Progress 1882-83-84, p. 32 M.—is from a natural exposure of the same seam on the north side of the river.] Structure somewhat coarse lamellar, made up of alternating layers of a greyish-black, somewhat dull, and bright black coal; it contains a large amount of brownish-yellow resin diffused through its substance, as also an occasional film of calcite; the specimen examined was hard and firm; fracture, on the whole, irregular, that of the more lustrous layers, occasionally imperfectly conchoidal; does not soil the fingers; powder dark brown inclining to blackish-brown; it communicates a pale brownish-yellow color to a boiling solution of caustic potash; resists exposure to the air.

Analyses of.

Analyses by slow and fast coking gave:

	Slow coking.	Fast coking.
Hygroscopic water	4·41	4·41
Volatile combustible matter	33·89	40·32
Fixed carbon	54·70	48·27
Ash	7·00	7·00
	100·00	100·00
Coke, per cent	61·70	55·27
Ratio of volatile combustible matter to fixed carbon	1 : 1·61	1 : 1·20

It yields—by slow coking, a non-coherent coke—by fast coking, a firm compact coke, the coking being doubtless materially influenced by the presence of the resin; the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a brownish-red color,—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a slaggy mass.

Coal from Peter seam, Marten Creek, Rocky Mountains.

63.—Coal—From the Peter seam, second crossing, Marten Creek, Crow Nest Pass, Rocky Mountains, British Columbia. Seam said to be fourteen feet thick. Geological position—Cretaceous, Kootanie series. Taken thirty feet in from outcrop. Locality

referred to by Dr. G. M. Dawson in Annual Report for 1885, p. 75 B.

This coal has a crumpled, foliated structure; shows slickensides color greyish-black to black; lustre resinous—that of the slickensided surfaces occasionally inclining to vitreous; firm; fracture irregular; slightly soils the fingers; does not contain any interlaminated calcite but occasionally, here and there, a delicate film of iron-pyrites; powder brownish-black; it communicates a faint brownish-yellow tinge to a boiling solution of caustic potash; resists exposure to the air,

Specific gravity 1·3052 (temp. 15·5°C.)—Weight of one solid cubic foot, calculated from the specific gravity, 81·57 pounds.

Analyses by slow and fast coking gave: Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	1·79	1·79
Volatile combustible matter	25·45	33·04
Fixed carbon	69·14	61·55
Ash	3·62	3·62
	100·00	100·00
Coke, per cent	72·76	65·17
Ratio of volatile combustible matter to fixed carbon	1:2·72	1:1·86

An ultimate analysis gave:

		Exclusive of sulphur, ash, and hygroscopic water.
Carbon	80·51	85·57
Hydrogen	5·20	5·53
Oxygen and nitrogen	8·37	8·90
Sulphur	0·51	—
Ash	3·62	—
Hygroscopic water	1·79	—
	100·00	100·00

Calorific power,* experimental, determined by Thompson's calorimeter Calorific power of,—experimental.

Indicated power of fuel in calories 8050
Indicated evaporative power .... 14·99 pounds of water (at 100°C.) per pound of fuel.

deducting the units of heat necessary to vaporise the hygroscopic

* For data employed in calculating the calorific power, see Report of Progress, 1882-83-84, p. 4 M. under V'., and p. 43 M. et seq. under heading "Remarks on accompanying tables."

and combined water, and water of combustion of the fuel, we have an

Indicated power of fuel in calories 7790
Indicated evaporative power ....14·51 pounds
of water (at 100°C.) per pound of fuel,

and these latter figures will express the greatest effect obtainable from this fuel, when used in generating steam.

Calorific power, of,—theoretical

Calorific power, theoretical, calculated from its chemical composition.

Expressed in calories 7990
Pounds of water (at 100°C.) evaporated by 1 lb. of fuel 14.88

deducting from these figures the heat units required to vaporise the hygroscopic and combined water, and water of combustion of the fuel, we obtain the following values:

Expressed in Calorics..............................7730
Pounds of water (at 100°C,) evaporated by 1 lb. of fuel 14.39

which latter give the closest approximation to the available heat.

It yields—by slow coking, a non-coherent coke—by fast coking, a compact, firm, coherent coke, in concentric layers, in which the form of the particles of coal from which it has been derived is entirely obliterated; the gases evolved during coking burnt with a yellow, luminous, smoky flame. Color of the ash white with a faint reddish tinge,—exposed to a bright red heat it does not become agglutinated, at a most intense red heat it becomes slightly fritted.

Coal from Jubilee seam, Marten Creek, Rocky Mountains.

64.—Coal—From the Jubilee seam, second crossing, Marten Creek, Crow Nest Pass, Rocky Mountains, British Columbia. Seam said to be thirty feet thick. Geological position—Cretaceous, Kootanie series. Taken fifty-five feet in from outcrop. Locality referred to by Dr. G. M. Dawson in Annual Report for 1885, p. 75 B.

The description given of the immediately preceding coal, viz., that from the Peter seam, applies also to this one, the only difference being that this coal did not contain any visible iron-pyrites, and communicated a very pale brownish-yellow, and hence a somewhat more decided, color to a boiling solution of caustic potash.

Specific gravity 1·3088 (temp. 15·5°C.)—Weight of one solid cubic foot, calculated from the specific gravity, 81·80 pounds.

Analyses by slow and fast coking gave: Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	1·89	1·89
Volatile combustible matter	24·88	30·41
Fixed carbon	68·86	63·33
Ash	4·37	4·37
	100·00	100·00
Coke, per cent	73·23	67·70
Ratio of volatile combustible matter to fixed carbon	1:2·77	1:2·08

An ultimate analysis gave:

		Exclusive of sulphur, ash, and hygroscopic water.
Carbon	80·04	85·82
Hydrogen	4·94	5·30
Oxygen and nitrogen	8·28	8·88
Sulphur	0·48	—
Ash	4·37	—
Hygroscopic water	1·89	—
	100·00	100·00

Calorific power, experimental, determined by Thompson's calorimeter: Calorific power of,—experimental.

Indicated power of fuel in calories........ 8026
Indicated evaporative power........ 14·94 pounds of water (at 100° C.) per pound of fuel.

deducting the heat units required to vaporise the hygroscopic and combined water, and water of combustion of the fuel, we have an

Indicated power of fuel in calories........ 7778
Indicated evaporative power........ 14·48 pounds of water (at 100° C.) per pound of fuel.

and these latter figures will express the greatest effect obtainable from this fuel, when used in generating steam.

Calorific power, theoretical, calculated from its chemical composition: Calorific power of,—theoretical

Expressed in calories........ 7866
Pounds of water (at 100° C.) evaporated by 1 lb. of fuel..14·64

deducting from these figures the heat units required to vaporise

the hygroscopic and combined water, and water of combustion of the fuel, we obtain the following values:

Expressed in calories	7618
Pounds of water (at 100° C.) evaporated by 1 lb. of fuel	14 18

which latter give the closest approximation to the available heat. It yields—by slow coking, a non-coherent coke—by fast coking, a compact, firm, coherent coke, in concentric layers, in which the form of the particles of coal from which it has been derived is entirely obliterated; the gases evolved during coking burnt with a yellow, luminous, smoky flame. Color of ash, white—exposed to a bright red heat it remains unaffected, at a most intense red heat it becomes fritted.

Coal from north of Coal Harbor, Vancouver Island.

65.—Coal—From shaft sunk on two to three feet seam north of Coal Harbor, Quatsino Sound, Vancouver Island, British Columbia. Geological position—Cretaceous. Collected by Dr. G. M. Dawson, and referred to by him in Annual Report for 1886, p. 93 B.

Structure, very fine lamellar; the lines of bedding, which are very numerous and close together, are almost obliterated—compact; it is here and there intersected by thin plates of calcite, as also by an occasional film of pyrite; color, greyish-black—almost black; lustre resinous; hard and firm; fracture uneven; does not soil the fingers; powder dark brown, inclining to blackish-brown; it communicates only a just perceptible yellowish tinge to a boiling solution of caustic potash; resists exposure to the air; in appearance it resembles some varieties of coal of the Carboniferous system.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	1·05
Volatile combustible matter	34·38
Fixed carbon	54·01
Ash	10·56
	100·00
Coke, per cent	64·57
Ratio of volatile combustible matter to fixed carbon	1 : 1·57

It yields—by fast coking a firm, compact coke, in concentric layers, in which the form of the particles of coal from which it has been derived is perfectly obliterated; the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a pale, dull yellowish-white color; exposed to a bright red heat, it

does not become agglutinated, at a most intense red heat it becomes slightly fritted.

66.—Coal—From a seam near Ya-koun River,—which flows into Massett Inlet—about twelve miles to the north of Skidegate Inlet, Graham Island, Queen Charlotte Islands, British Columbia. Seam said to be eighteen feet thick. Geological position—Cretaceous.

Coal from Ya-koun River, Graham Island, Queen Charlotte Islands.

Structure, compact; hard and firm; color, black; lustre, resinous, in parts brilliant; fracture uneven, occasionally somewhat conchoidal; it is, here and there, intersected by thin plates of gypsum and calcite, as also by a few films of pyrite; does not soil the fingers; powder dark brown, inclining to blackish-brown; it communicates a just perceptible brownish-yellow tinge to a boiling solution of caustic potash; resists exposure to the air; in appearance it closely resembles some varieties of coal of the Carboniferous system.

Analyses by slow and fast coking gave:

Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	2·65	2·65
Volatile combustible matter	30·59	38·19
Fixed carbon	61·33	53·73
Ash	5·43	5·43
	100.00	100·00
Coke, per cent	66.76	59·16
Ratio of volatile combustible matter to fixed carbon	1 : 2·00	1:1·41

It yields—by slow coking, a non-coherent coke—by fast coking, a firm, compact coke, in concentric layers, in which the form of the particles of coal from which it has been derived is entirely obliterated; the gases evolved during coking burnt with a yellow, luminous, smoky flame. Color of the ash, light reddish-white—when exposed to a bright red heat it remains unaffected, at a most intense red heat it becomes slightly fritted.

This coal agrees very closely in composition with that of the Newcastle seam, Wellington Mine, Vancouver Island, analyses of which are given in Report of Progress for 1882-84, p. 37 M., specimen No. 33.

67.—Coal—From Ki-uk River, the mouth of which is about three miles south of Beaver Harbor, Vancouver Island, British Columbia. Seam six inches thick. Geological position—Cretaceous.

Coal from Ki-uk River, Vancouver Island.

Collected by Dr. G. M. Dawson, and referred to by him in Annual Report for 1886, p. 62 B.

Structure, for the most part, tolerably fine lamellar, with an intervening broad layer of compact, homogeneous, velvet-black, jet-like material, and an occasional interposed layer of mineral charcoal; apart from the latter, does not soil the fingers; it is intersected by numerous films of calcite; hard and firm; powder dark brown, inclining to blackish-brown; it communicates a pale brownish-yellow color to a boiling solution of caustic potash; resists exposure to the air.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	3·68
Volatile combustible matter	39·29
Fixed carbon	47·03
Ash	10·00
	100·00
Coke, per cent	57·03
Ratio of volatile combustible matter to fixed carbon 1 : 1·19	

It yields—by fast coking, a firm, coherent coke; the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a light reddish-grey color—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a more or less vitrified mass.

Coal from Suquash, Vancouver Island.

68.—Coal—From Suquash, north-east end of Vancouver Island, British Columbia. From site at which coal was mined by the Hudson Bay Company. There are two seams at this locality, the upper—that from which the present specimen was taken—having a thickness of from one to two feet, and which is separated from the lower seam of some six inches, by a parting of about one foot of soft shale. Geological position—Cretaceous. Collected by Dr. G. M. Dawson, and referred to by him in Annual Report for 1886, p. 62 B.

Structure, on the whole, moderately fine lamellar, of grayish-black color and dull lustre, with occasional somewhat coarse layers of shining, velvet-black coal; it is, here and there, intersected by a few films of calcite, and contains, in parts, a little lemon-yellow subtransparent resin; hard and firm; fracture uneven; powder dark brown, inclining to blackish-brown; it communicates a brownish-yellow color to a boiling solution of caustic potash; resists exposure to the air.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	5·03
Volatile combustible matter	41·51
Fixed carbon	46·52
Ash	[illegible]
	100·00
Coke, per cent	53·46
Ratio of volatile combustible matter to fixed carbon	1 : 1·12

It yields—by fast coking, a moderately firm coke; the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a light bluish-grey color—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it readily fuses to a vitrified mass.

69.—Coal—From a small stream, three-quarters of a mile due south of mouth of Klik-si-wi River, north-west coast of Vancouver Island, British Columbia. Seam sixteen inches thick. Geological position—Cretaceous. Collected by Dr. G. M. Dawson, and referred to by him in Annual Report for 1886, p. 62 B. Coal from Klik-si-wi River, Vancouver Island

Structure, tolerably fine lameller—compact; color black; lustre resinous; hard and firm; fracture uneven; does not soil the fingers; powder dark brown, inclining to blackish-brown; it communicates a brownish-yellow color to a boiling solution of caustic potash; on exposure to the air it becomes, in parts, incrusted with a white efflorescence, resulting from the oxidation of iron pyrites; in appearance, it is not unlike some varieties of coal of the Carboniferous system.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	3·65
Volatile combustible matter	42·23
Fixed carbon	39·84
Ash	14·28
	100·00
Coke, per cent	54·12
Ratio of volatile combustible matter to fixed carbon	1 : 0·94

It yields—by fast coking, a coherent but tender coke; the gases evolved during coking burnt with a yellow, luminous, smoky flame; color of the ash, reddish-brown—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a more or less vitrified mass.

Semi-anthracite from Marsh's Mine, Rocky Mountains.

70.—Semi-anthracite—From Marsh's mine, about one and a-half miles south of Bow River, at Gap siding, Rocky Mountains, District of Alberta, N.W.T. There are two seams, an upper about twelve feet thick, and a lower about ten feet thick, separated by about fifty feet of shales and sandstone. Geological position—Cretaceous. Collected by Mr. R. G. McConnell, and referred to in Annual Report for 1885, p. 133 B.

Material of upper seam:

Upper seam.

Structure compact, highly contorted, shows slickensides in an eminent degree; made up of alternating layers of a greyish-black, dull, and jet-black coal of brilliant lustre; brittle; fracture, on the whole, uneven, that of the more lustrous layers conchoidal; does not soil the fingers; the specimen examined was hard and firm; powder black; it communicated only a just perceptible yellowish tinge to a boiling solution of caustic potash; resists exposure to the air.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	0·70
Volatile combustible matter	11·03
Fixed carbon	79·78
Ash	8·49
	100·00
Ratio of volatile combustible matter to fixed carbon	1 : 7·23

It yields a non-coherent coke; when heated in a covered crucible it evolves a small amount of yellowish, somewhat luminous, almost smokeless flame. The ash, which is white, does not agglutinate at a bright red heat, and at a most intense red heat becomes only very slightly fritted.

Lower seam.

71.—Material of lower seam:

Structure foliated, crumpled—made up of layers of dull greyish-black material, consisting, apparently, of carbonaceous shale and velvet-black coal of brilliant lustre; shows slickensides; does not soil the fingers; hard and firm; at a first glance, might readily be mistaken for a fuel of excellent quality.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	1·02
Volatile combustible matter	7·24
Fixed carbon	36·16
Ash	55·58
	100·00

NATURAL WATERS.

1.—Water from one—that usually referred to as the principal spring —of the thermal springs at Banff, District of Alberta, North West Territory. Collected by Mr. R. G. McConnell. Water from thermal spring at Banff, District of Alberta, N.W.T.

Referring to this spring Mr. McConnell says—"The water has a temperature of 111°F. in summer, but it is said to rise to 119°F. in winter. The lower temperature in summer may be caused by the water being affected to some extent by the surface drainage, which is more active at that season. It has a regular flow, and is forced up in large quantities through an aperture several inches in diameter."

Mr. Frank D. Adams has made an analysis of this water and with the following results:—

At the time of examination it contained a certain amount of suspended and sedimentary matter, this for 1000 parts, by weight, of the water amounted to 0·0288, and was found to be composed of a dark colored sand, a portion of which consisted of minute grains of magnetic iron-ore, some argillaceous and vegetable matter, small quantities of carbonates of iron, lime, and magnesia, together with a very small amount of sulphate of lime. The filtered water had a specific gravity, at 15·5°C., of 1000·99. It was colorless, even when viewed in a column two feet in length, was devoid of odor and any marked taste; reaction, faintly alkaline. 1000 parts, by weight, of the water, at 15·5°C., contained :—

Potassa	·0052
Soda	·0097
Lime	·2960
Magnesia	·0690
Alumina (very small amount)	undet.
Ferrous oxide	·0008
Chlorine	·0067
Sulphuric adid	·4784
Carbonic acid	·1454
Silica	·0398
Organic matter	trace
	1·0510
Less oxygen equivalent to chlorine	·0015
	1·0495

The foregoing acids and bases are most probably combined in the water as follows:

(Carbonates being calculated as mono-carbonates, and all the salts estimated as anhydrous)

Water from thermal spring at Banff, District of Alberta, N.W.T., cont.

Chloride of sodium	·0110
Sulphate of soda	·0089
" potassa	·0096
" magnesia	·2070
" lime	·5627
Carbonate of lime	·1148
" iron	·0013
Alumina	undet.
Silica	·0398
Organic matter	trace.
	·9551

Total dissolved solid matter, by direct experiment, dried at 180°C., 0·9743.

Carbonic acid, half-combined	·0510
" , free	·0434
	1·0495

An Imperial gallon of the water—at the aforementioned temperature—would contain:—

(Carbonates calculated as anhydrous bi-carbonates, and the salts without their water of crystallisation.)

	Grains.
Chloride of Sodium	0·771
Sulphate of soda	0·624
" potassa	0·673
" magnesia	14·504
" lime	39·428
Bi-carbonate of lime	11·583
" iron	0·126
Alumina	undet.
Silica	2·789
Organic matter	trace.
	70·498
Carbonic acid, free	3·041
	73·539

The water was examined for lithia, iodine, and bromine, but no other constitutents. Distinct evidence was obtained of the presence of lithia. Iodine and bromine were not detected: this does not necessarily imply that they are not present in the water, inasmuch as the amount of water operated on was far less than would be required for the detection of traces, or even very small quantities of these substances.

2.—From a spring in the vicinity of the Belvedere iron mine, lot eight

of the ninth range of Ascot, Sherbrooke county, Province of Quebec. Examined for Mr. E. Clark. Water from a spring near Belvedere iron mine, Ascot, Sherbrooke county, P.Q.

Mr. E. B. Kenrick made a qualitative examination of this water and found it to contain:—

Potassa	trace.
Soda	small proportion.
Lime	rather large proportion.
Magnesia	rather large proportion.
Ferrous oxide	trace.
Sulphuric acid	large proportion.
Carbonic acid	small proportion.
Silica	trace.
Chlorine	small proportion.

Total dissolved saline matter, dried at 180°C., equalled 0·0746 parts in 1000.

IRON ORES.

1.—Red hematite from Mr. W. McDonald's farm near Avondale Post Office, about one hundred yards north of T roads at the house, on the west side of the main road, Pictou county, Nova Scotia. Hematite from near Avondale Post Office, Pictou county, N.S.

The sample, which was collected by Mr. Hugh Fletcher, and consisted of picked specimens, weighed five pounds. A fair average of the same was found, by Mr. E. B. Kenrick, to contain:—

Metallic iron	33·76 per cent.

2.—Magnetic iron ore from the vicinity of Kinnear's Mills, township of Leeds, Megantic county, Province of Quebec. Examined for Mr. J. H. Bartlett. Magnetite from vicinity of Kinnear's Mills, Megantic county, P.Q.

The sample consisted of an association of fine crystalline magnetite and hematite, through which was disseminated a large amount of a siliceous gangue and some iron-pyrites. Weight of specimen, about seven and a-half pounds. Mr. E. B. Kenrick found it to contain:—

Metallic iron	37·23 per cent.
Titanium dioxide	none.
Insoluble matter	44·31 per cent.

3.—A specular schist from lot seven, range nine of Sutton, Brome county, Province of Quebec. Specular schist from Sutton, Brome county, P.Q.

A sample of this material, forwarded to the Survey for examination, was found by Mr. F. D. Adams to contain about forty per cent. of insoluble matter, and gave a very strong re-action for titanic acid.

Magnetite from lot 16, range 2 of Wollaston, Hastings county, Ont.

4.—Magnetic iron-ore from lot sixteen, range two of Wollaston, Hastings county, Ontario. This and the two following specimens were examined for Mr. W. Jenkins. The determinations were made by Mr. E. B. Kenrick. It contained:—

Metallic iron	28·94 per cent.
Titanium dioxide	none.

Magnetite from lot 15, range 2 of Wollaston, Hastings county, Ont.

5.—Magnetic iron-ore from lot fifteen, range two of Wollaston, Hastings county, Ontario.

A fine crystalline magnetite: it contained:—

Metallic iron	56·50
Titanium dioxide	none.

Magnetite from lots 9 and 10, range 15 of Wollaston, Hastings county, Ont.

6.—Magnetic iron-ore from lots nine and ten, range fifteen of Wollaston, Hastings county, Ontario.

A fine crystalline magnetite: it contained:—

Metallic iron	28·42 per cent.
Titanium dioxide	trace.

Magnetite from Bedford, Frontenac county, Ont.

7.—Magnetic iron-ore from lot twenty-eight, range four of Bedford, Frontenac county, Ontario. Examined for Mr. W. Davis.

A coarse crystalline magnetite. Determinations by Mr. E. B. Kenrick gave:

Metallic iron	62·98 per cent.
Titanium dioxide	none.

Magnetite from South Sherbrooke, Lanark county, Ont.

8.—Magnetic iron-ore from lot nineteen, range three of South Sherbrooke, Lanark county, Ontario. Examined for Mr. W. A. Allan.

Small crystals of apatite were disseminated through portions of this sample. A fair average of thirty-seven pounds of this ore was found, by Mr. E. B. Kenrick, to contain:—

Metallic iron	40·81 per cent.
Titanium dioxide	none.

Magnetite from Carlow, Hastings county, Ont.

9.—Magnetic iron-ore from a deposit occurring on the north halves of lots six and seven, range sixteen of Carlow, Hastings county, Ontario. The examination was conducted by Mr. F. D. Adams.

The sample received was made up of fragments which differed materially in appearance, some consisting, apparently, of very pure, others of a very impure ore. The former were separated from the latter, thus dividing the original material into two portions—A, and B. Portion A, consisting of the apparently pure fragments, constituted 36·42 per cent. of the original sample. On

closely examining the various fragments composing it, it was found that whereas some consisted of a coarsely crystalline magnetite, strongly magnetic, and having a distinct octahedral cleavage, the remainder were not at all magnetic and proved to consist of ilmenite. This portion contained:—

Metallic iron	68·47 per cent.
Titanium dioxide	undet.

Portion B, contained a large amount of rock matter. Some of the fragments consisted, apparently, of gneiss carrying more or less magnetite. Analysis gave:—

Metallic iron	34·16 per cent.
Titanium dioxide	trace.

The insoluble matter amounted to over forty per cent. Calculation showed the sample, as received, to contain:—

Metallic iron	46·66 per cent.
Titanium dioxide	undet.

10.—Magnetic iron-ore from the vicinity of Little Gull Lake, District of Thunder Bay, Lake Superior, Ontario. Collected by Mr. E. D. Ingall. There were two specimens, taken from different points. The examinations were made by Mr. E. B. Kenrick.

Magnetite from Little Gull Lake, District of Thunder Bay, Ont.

The one specimen was strongly magneti-polar. It contained:

Metallic Iron	39·76 per cent.
Titanium dioxide	none.

The other was also found to possess polarity, but in a far less degree than the one just alluded to. Determinations gave:

Metallic iron	45·57 per cent.
Titanium dioxide	none.

11.—Hematite from Big Island, Lake Winnipeg, Manitoba. Examined for Mr. F. Proudfoot.

Hematite from Big Island, Lake Winnipeg, Man.

This specimen contained a good deal of finely disseminated iron-pyrites, also a large amount of a calcareous and siliceous gangue. Determinations—by Mr. F. D. Adams—of the more important constituents, gave:

Ferric oxide	50·343
Phosphoric acid	0·009
Sulphur	2·026
Insoluble matter	22·330
Water, hygroscopic	0·644
Metallic iron	35·240
Phosphorus	0·004
Sulphur	2·026

Magnetite from Albany River.

12.—Magnetic iron-ore from the Albany River, two and a-half miles below the junction of the Etow-i-ma-mi. Collected by Dr. R. Bell.

A very fine-granular, almost compact, dark bluish-grey magnetite. Agreeably with the results of determinations made by Mr. E. B. Kenrick, it contained:—

Metallic iron	42·09 per cent.
Titanium dioxide	none.

Hematite from near Spence's Bridge, Thompson River, B.C.

13.—Hematite, var. specular iron, from the vicinity of Spence's Bridge, Thompson River, Cascade Range, British Columbia. Received from Mr. James Crawford. Determinations by Mr. E. B. Kenrick, gave:

Metallic iron	33·13 per cent.
Titanium dioxide	none.

Gold and Silver Assays.

GOLD AND SILVER ASSAYS.

Province of Nova Scotia.

Assays Nos. 1 and 2 were conducted by Mr. F. D. Adams.

Province of Nova Scotia.

1.—From North Bend, East Bay, Cape Breton county. Examined for Mr. E. T. Moseley.

It consisted of a dark-brown zinc-blende, coated with ferric hydrate and other decomposition products. Weight of specimen, four ounces. It was found to contain:

Gold	none.
Silver	trace.

2.—Said to have come from near Truro, Colchester county. Examined for Mr. E. A. Charters.

It consisted of galena in association with a dark-brown limestone. The former constituted, approximately, four-fifths, by weight, of the whole. Weight of specimen, ten and a-half ounces.

It contained neither gold nor silver.

3.—From St. Ann's Mountain at Big Bras d'Or, Victoria county, Cape Breton. Examined for Mr. J. McPherson.

A greyish-white sub-translucent quartz, carrying a somewhat large amount of iron-pyrites, together with some magnetite: the whole was more or less stained with ferric hydrate. Weight of specimen, seven and a-half ounces. Assays, by Mr. R. A. A. Johnston, gave:

Gold	trace.
Silver	none.

Gold and Silver Assays, cont.

Province of New Brunswick.

Province of New Brunswick

4.—From the "Mineral Vale" property, parish of Alma, Albert county. Examined for Mr. E. A. Charters.

A finely-crystalline galena, together with a little copper-pyrites, disseminated through a dolomitic gangue. Weight of specimen, fifteen and three-quarter ounces. Mr. E. B. Kenrick found it to contain:

Gold.................. trace.
Silver................. 1·458 ounce to the ton of 2,000 lbs.

Province of Quebec.

Assays Nos. 5 *to* 8 *and* 22 *to* 27 *inc., were conducted by Mr. E. B. Kenrick—Nos.* 9 *to* 14 *inc., by Mr. R. A. A. Johnston, and Nos.* 16 *to* 21 *inc., by Mr. F. D. Adams.*

Province of Quebec.

5.—From one of numerous veins in the vicinity of the town of Sherbrooke, Sherbrooke county.

It consisted of an association of iron-pyrites, galena, and quartz. Weight of specimen, ten and a-half ounces. Assays gave:

Gold.................. trace.
Silver................. 9·479 ounces to the ton of 2,000 lbs.

6.—From the township of Litchfield, Pontiac county. Examined for Mr. H. K. Egan.

A coarsely crystalline galena, in association with a very small quantity of calcite. Weight of specimen, three and a-quarter ounces. It contained:

Gold.................. none.
Silver................. 2·188 ounces to the ton of 2,000 lbs.

7.—From range nine, lot twenty-four of Cranbourne, Dorchester county. Quartz, in association with a dark bluish-grey shale; it contained a little iron-pyrites and magnetite, and was in parts stained with ferric hydrate. Weight of specimen, thirteen ounces.

It contained neither gold nor silver.

8.—From Onslow, Pontiac county.

A coarsely crystalline galena, in association with a small quantity of calcite. Weight of specimen, nine and a-half ounces. It was found to contain:

Gold............. none.
Silver............ 0·729 of an ounce to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of Quebec, cont.

9.—From lot twelve, range one, N. E. St. Francis, Beauce county.

A white sub-translucent quartz, in association with chloritic schist; it contained a good deal of iron-pyrites, also a small quantity of galena, and was more or less stained with ferric hydrate. Weight of specimen, one pound one ounce. Assays showed it to contain:

Gold............ 0·117 of an ounce to the ton of 2,000 lbs.
Silver........... none.

10.—From the Coulonge River, about eighteen miles up.

A greyish-white to white sub-translucent quartz, carrying a somewhat large amount of zinc-blende, and, here and there, a few specks of galena and magnetic-pyrites. It was in parts stained with ferric hydrate. Weight of specimen, one pound two ounces.

It contained neither gold nor silver.

11.—From near the headwaters of the Abitibi branch of the Ottawa River, eight miles south of height of land. Examined for Mr. C. C. Farr.

An association of copper-pyrites and quartz. Weight of specimen, one and a-half ounce. It contained:

Gold.. trace.
Silver.. none.

12.—From R. N. Klocks and Company's limit, north shore of Lac des Quinze. Examined for Mr. C. C. Farr.

An association of iron-pyrites, magnetic-pyrites, and translucent quartz. Weight of specimen, four and a-half ounces. Assays gave:

Gold.. trace.
Silver.. none.

13.—From the north-east end of Lac des Quinze.

Consisted of iron-pyrites in a gangue of white and greyish-white sub-translucent quartz, in parts coated with with ferric hydrate. Weight of specimen, eight ounces. Assays showed it to contain:

Gold.. trace.
Silver.. trace.

14.—From lot six, range eleven, of Whitton, Compton county.

A full description of this material will be found under Miscellaneous Examinations, examination No. 4, where it is referred to as "the bulk of the material." It was found to contain:

Gold.. trace.
Silver.. none.

Gold and Silver Assays, cont.

Province of Quebec, cont.

15.—From the so-called Bothwell gold mine, range nine, lot seventeen, of Buckingham, Ottawa county. Taken from a depth of about seven or eight feet. This, and the following specimen were examined for Mr. W. A. Allan.

It consisted of an association of quartz and felspar, together with a little pyroxene and garnet, a trifling amount of apatite, some graphite and iron-pyrites. Weight of specimen, four pounds ten ounces.

It contained neither gold nor silver.

16.—From the same locality and opening as the preceding specimen, but from a depth of about twenty feet.

This consisted of a somewhat coarsely crystalline rock, composed of quartz, grey felspar, a good deal of calcite and a little pyroxene. It contained a large quantity of pyrite and hydrated peroxide of iron; also, a little pyrrhotite. Weight of specimen, one pound.

It contained neither gold nor silver.

17.—From lot nineteen, range five of Buckingham, Ottawa county. Examined for Mr. L. P. Labouglie.

A grey garnetiferous gneiss, through which was disseminated a little graphite, carrying a somewhat large amount of iron-pyrites; the latter constituting a band in the rock. Weight of specimen, two and a-half pounds. It contained:

Gold	trace.
Silver	none.

18.—This, and the two following specimens were stated, by Mr. W. Macintosh, for whom they were examined, to have come from the vicinity of Whitefish Lake, Ottawa county.

It consisted of a very fine-grained steel-grey ore, consisting of an intimate mixture of zinc-blende, galena, copper-pyrites, quartz and calcite. The copper-pyrites was present only in very small amount; the galena constituted about 13·8 per cent., by weight, of the whole. Weight of specimen, four pounds six ounces. Assays showed it to contain:

Gold	distinct trace.
Silver	13·125 ounces to the ton of 2,000 lbs.

19.—A white translucent quartz, in association with a small quantity of a dark, somewhat micaceous schist; it held a small amount of coarsely crystalline iron-pyrites. Weight of specimen, three pounds twelve ounces.

It contained neither gold nor silver.

Gold and Silver Assays, cont.

Province of Quebec, cont.

20.—Consisted of greyish quartz, carrying a good deal of iron-pyrites; also, a little galena and zinc-blende. Half of one of the fragments consisted of an impure grey limestone, apparently the wall rock. Weight of specimen two pounds fifteen and a-half ounces. Assays gave:

Gold...........	0·058	of an ounce to the ton of 2,000 lbs.
Silver.............	0·262	" " "

21.—From lot ten, range four of Calumet, Pontiac county.

A more or less intimate association of zinc-blende and galena, together with small quantities of iron-pyrites. The proportion of the two latter, more especially the galena, to the former, varied greatly in different specimens. A fair average of numerous specimen, was found, on assay, to contain:

Gold..................	trace.	
Silver..................	11·666	ounces to the ton of 2,000 lbs.

22.—This, and the four following specimens, are from quartz veins occurring on a hill on the north side of the Ottawa River, and opposite to the village of Mattawa. They were collected, at the instance of Dr. R. Bell, by Mr. A. E. Barlow and in such wise as to thoroughly represent the respective veins from which they were taken.

The material from the first vein, which occurs about one and a half miles north-east of the Mattawa village, consisted of a translucent quartz in association with a little red and white felspar. Weight of specimen, twelve ounces.

It contained neither gold nor silver.

23.—From a vein about one hundred feet from, and running parallel with, the last mentioned. Width of vein, about seven feet.

A translucent quartz. Weight of specimen, one pound thirteen ounces.

It contained neither gold nor silver.

24.—From a vein occurring about half a mile W. 15° N. of that from which the last mentioned specimen was taken. Strike of vein about S. 55° W.

Translucent quartz in association with a little felspar. Weight of specimen, eight pounds fourteen ounces.

It contained neither gold nor silver.

25.—From a vein about two feet wide, of much the same character and having the same strike as the one last referred to.

Consisted of a translucent quartz in association with a little felspar. Weight of specimen, four pounds nine ounces. Gold and Silver Assays, cont.

Province of Quebec, cont.

It contained neither gold nor silver.

26.—From a vein occurring at the back of the hill.

It consisted of a translucent quartz, through which was disseminated small flakes of a gold-yellow colored mica. Weight of specimen, four and three-quarter ounces.

It contained neither gold nor silver.

27.—From an opening on the north-west claim of the Mattawa Gold Mining Company. The claim is three miles due north of the village of Mattawa. Collected by Dr. R. Bell.

A translucent quartz with which was associated a little felspar, and in some instances a micaceous schist. Weight of specimen, five pounds.

It contained neither gold nor silver.

Province of Ontario.

Assays Nos. 28 *to* 49 *inc., were conducted by Mr. E. B. Kenrick —Nos.* 50 *to* 53 *inc., by Mr. R. A. A. Johnston, and Nos.* 54 *to* 56 *inc., by Mr. F. D. Adams.*

28.—This, and the two following specimens were collected by Dr. R. Bell. Province of Ontario.

From main opening, McCool's Mill location, Mattawa Gold Mining Company, about half a mile north of McCool's Mill, Mattawan River, and three miles west of Mattaw village, district of Nipissing.

It consisted of translucent quartz in association with some felspar. Weight of specimen, three pounds six ounces.

It contained neither gold nor silver.

29.—From the south opening, McCool's Mill location, Mattawa Gold Mining Company, about thirty feet south-west of the opening whence the last mentioned specimen was taken.

A translucent quartz. Weight of specimen, three pounds.

It contained neither gold nor silver.

30.—From a vein running N. 45° E. (mag.), and about two chains north-west of the opening last referred to.

Consisted of a translucent quartz in association with a little felspar. Weight of specimen, two and three-quarter pounds.

It contained neither gold nor silver.

Gold and Silver Assays, cont.

Province of Ontario, cont.

31.—From lot three, range one of the township of Snider, district of Algoma. Examined for Mr. T. M. Kirkwood.

A moderately coarse crystalline galena in the form of more or less contorted layers, having an average thickness of about a-quarter of an inch. Assays gave:

Gold.................none.
Silver.................5·104 ounces to the ton of 2,000 lbs.

32—From a ten feet vein at the northern end of Lake Temagami, district of Nipissing. Received from Mr. E. B. Haycock.

It consisted of iron-pyrites through which was disseminated a little quartz and calcite. Weight of specimen, seven and a-quarter ounces. It was found to contain:

Gold..trace.
Silver..none.

33.—From about six miles from Gravel River Station on the line of the Canadian Pacific Railway, district of Thunder Bay. Vein eighteen inches wide. Received from Mr. Hugh Wilson.

A coarsely crystalline galena in a gangue consisting almost exclusively of quartz. Weight of specimen, one and a-quarter ounce. It contained:

Gold.................[illegible]
Silver.................1·094 ounce to the ton of 2,000 lbs.

34.—This, and the following fifteen specimens were collected by Mr. E. D. Ingall.

From Jarvis Island, north-west shore of Lake Superior, between Thunder Bay and Pigeon River.

An association of calcite and a greyish-green chloritic mineral, through which was disseminated a little iron-pyrites and zinc-blende. Weight of specimen, ten and a-quarter ounces. It was found to contain:

Gold.... ....none.
Silver............0·350 of an ounce to the ton of 2,000 lbs.

35.—This, and the two following specimens are from location 97 T., Rabbit Mountain district.

Zinc-blende in a gangue consisting of a dark grey shale, calcite and some fluorite. The gangue constituted but a small proportion, by weight, of the whole. Weight of specimen, one pound eleven ounces. It was found, on assay, to contain:

Gold......... ....trace.
Silver................336·700 ounces to the ton of 2,000

36.—From upper slope. Gold and Silver Assays, cont.

It consisted of zinc-blende and a trifling amount of iron-pyrites, in a gangue of calcite with a little fluorite. Weight of specimen, seven ounces. Assays gave: Province of Ontario, cont.

Gold..trace.
Silver..none.

37.—From bottom of shaft.

An association of a dark grey shale, quartz and some fluorite, carrying small quantities of zinc-blende and a little galena. Weight of specimen, six and a-half ounces.

It contained neither gold nor silver.

38.—From a vein on location 264 T., Whitefish Lake.

An association of quartz and calcite, with some shale and a little fluorite, carrying a trifling quantity of zinc-blende. Weight of specimen, two pounds five ounces. It was found to contain:

Gold.................none.
Silver...............1·867 ounces to the ton of 2,000 lbs.

39.—From a vein on location 176 T., Whitefish River.

It consisted of calcite, in association with a little quartz and fluorite, carrying small quantities of zinc-blende and a little galena. Weight of specimen, thirteen ounces.

It contained neither gold nor silver.

40.—From location R. 110, Whitefish Lake.

An association of calcite, shale, and small quantities of fluorite, carrying a little iron-pyrites and galena. Weight of specimen, eight and three-quarter ounces.

It contained neither gold nor silver.

41.—From location R. 235, Silver Mountain district.

An association of quartz and calcite. Weight of specimen, fifteen and a-quarter ounces.

It contained neither gold nor silver.

42.—From a vein on location 95 T., Silver Mountain district.

It consisted of calcite in association with a little fluorite, and contained, here and there, a trifling amount of silver-glance. Weight of specimen, five ounces. Assays gave:

Gold.................none.
Silver...............2·567 ounces to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of Ontario, cont.

43.—From a vein on Tchiatay's location, Silver Mountain district.

It consisted of calcite together with a little fluor, carrying small quantities of zinc-blende and some galena. Weight of specimen, fourteen ounces. It was found to contain:

Gold	trace.
Silver	none.

44.—From a vein on Woodside's location, Silver Mountain district.

An association of a white translucent quartz with a little shale, calcite, and fluorite, carrying small quantities of zinc-blende. Weight of specimen, eleven and a-half ounces.

It contained neither gold nor silver.

45.—From Silver Mountain vein, from test pit.

A dark grey shale with some quartz and a little fluorite, carrying a trifling amount of zinc-blende and silver-glance. Weight of specimen, two pounds eleven ounces. Assays showed it to contain:

Gold	trace.
Silver	353·442 ounces to the ton of 2,000 lbs.

46.—From Silver Mountain vein, No. 2 tunnel, breast.

An association of calcite and a dark grey shale with some quartz and fluorite, carrying a little iron-pyrites. Weight of specimen, fifteen ounces.

It contained neither gold nor silver.

47.—From Silver Mountain vein, No. 2 tunnel, near crosscut.

An association of calcite and shale together with some quartz and fluorite, carrying a little iron-pyrites, zinc-blende, and silver-glance. Weight of specimen, seventeen pounds. It contained:

Gold	district trace.
Silver	102·083 ounces to the ton of 2,000 lbs.

48.—From Osinawe Lake, Seine River district.

A milky white quartz, in association with a greenish-grey chloritic schist: it contained, here and there, a few specks of iron-pyrites and, in parts, cavities lined with ferric hydrate. Weight of specimen, fourteen and three-quarter ounces.

It contained neither gold nor silver.

49.—From Michipicoten Island, Lake Superior.

A white, reddish-white, and grey calcite in association with a

Gold and Silver Assays, cont.

Province of Ontario, cont.

small quantity of an apple-green talcose mineral. Weight of specimen, seven and a-half ounces. It was found to contain:

Gold	distinct trace.
Silver	0·467 of an ounce to the ton of 2,000 lbs.

50.—From lot two, range five, of Snider, district of Algoma. Examined by Mr. J. McCormick.

A greyish-white translucent to sub-transparent quartz, in association with a greenish chloritic mineral, carrying small quantities of iron-pyrites. It was more or less stained and coated with ferric hydrate. Weight of specimen, six pounds thirteen ounces. Assays gave:

Gold	trace.
Silver	none.

51.—From the Thompson vein, location H., township of McIntyre, Thunder Bay, Lake Superior. Examined for Mr. W. A. Allan.

A white sub-translucent quartz, in association with a dark-grey rock. It was slightly stained with ferric hydrate, and contained a little iron-pyrites. Weight of specimen. two and three-quarter pounds. Assays showed it to contain:

Gold	trace.
Silver	none.

52.—From the township of Escott, Leeds county. Examined for Mr. T. Storey.

It consisted of iron-pyrites with a somewhat large amount of intermixed ferric hydrate. Weight of specimen, ten ounces. It was found, on assay, to contain:

Gold	trace.
Silver	trace.

53.—From about five and a half miles south of Kinmount, Peterborough county.

An association of iron-pyrites and magnetic pyrites in a felspathic gangue: the latter constituted but a small proportion, by weight, of the whole. Weight of specimen, five and a-half ounces. Assays gave:

Gold	distinct trace.
Silver	none.

54.—From the south-east corner of township 94, district of Algoma. Examined for Mr. W. Russel.

Gold and Silver Assays, cont.

Province of Ontario, cont.

A greyish translucent quartz associated with a small quantity of a light colored micaceous mineral and holding a little iron-pyrites. Weight of specimen, two pounds. It contained:

Gold .... trace.
Silver .... none.

55.—From the vicinity of Sudbury Station on the line of the Canadian Pacific Railway, district of Nipissing.

Quartz carrying a small amount of copper-pyrites and magnetic pyrites. Weight of specimen, four and three-quarter ounces. It was found to contain:

Gold .... distinct trace.
Silver .... 0·414 of an ounce to the ton of 2,000 lbs.

56.—From lot sixteen, range three of the township of Dalhousie, county of Lanark. Examined for Mr. David MacLean.

An association of galena, calcite, and barite. The calcite constituted 17·7 per cent., and the barite about 40 per cent. of the material. Weight of specimen, two and three-quarter ounces. Assays showed it to contain:

Gold .... none.
Silver .... 1·951 ounce to the ton of 2,000 lbs.

District of Keewatin.

District of Keewatin.

57.—From an island eighteen miles south-west of Rat Portage, Lake of the Woods. Examined for Mr. J. C. Gough.

It consisted of quartz stained, and more or less coated, with ferric hydrate, with here and there a few specks of galena and iron-pyrites. Weight of specimen, nine and a-half pounds. Assays, by Mr. E. B. Kenrick, showed it to contain:

Gold .... 0·350 of an ounce to the ton of 2,000 lbs.
Silver .... 0·293 " " "

North-West Territory.

Assays Nos. 58 *to* 64 *inc., were conducted by Mr. F. D. Adams.*

North-we Territory.

58.—This, and the following five specimens were collected by Dr. G. M. Dawson.

From Hoo-che-koo Bluff, Lewes River, a branch of the Yukon.

An exceedingly fine grained, brown weathering, argillaceous rock, containing a little disseminated copper-pyrites and much stained with green carbonate of copper. The rock is traversed by

thin veins of white calcite. Weight of specimen, eleven ounces. Assays gave: Gold and Silver Assays, cont. North-west Territory, cont.

Gold............ minute trace.
Silver........... 0·088 of an ounce to the ton of 2,000 lbs.

59.—From Frances Lake, head of Liard River.

A greyish translucent quartz, somewhat stained with ferric hydrate and containing a little chloritic matter and iron-pyrites. Weight of specimen, ten ounces. It contained:

Gold...................................... minute trace.
Silver.................................... none.

60.—From Frances Lake, head of Liard River, from another exposure.

A greyish translucent quartz, traversed by small veins and strings of a very ferruginous dolomite, and associated with a little chloritic matter. Weight of specimen, one pound one ounce. Assays showed it to contain:

Gold... trace.
Silver... none.

61.—From Finlayson River, head of Liard River.

A grey translucent quartz, more or less coated with ferric hydrate. The specimen, which was made up of numerous fragments taken from different parts of a very large quartz vein, weighed eleven ounces.

It contained neither gold nor silver.

62.—From Pelly River, head waters of the Yukon.

A very fine grained dark grey siliceous rock, impregnated with mispickel and traversed by small veins of calcite. Weight of specimen, twelve ounces. It was found to contain:

Gold...................................... distinct trace.
Silver.................................... none.

63.—From Tagish or Tahko Lake, Lewes River, a branch of the Yukon.

A very fine grained, somewhat calcareous, greenish-grey, rusty weathering, felsite, through which was disseminated a little magnetic-pyrites. Weight of specimen, one pound seven ounces.

It contained neither gold nor silver.

64.—From a large vein in Red Mountain, Bennett Lake, Lewes River, Collected by Mr. W. Ogilvie.

A rather fine grained granitic rock holding a little magnetic

Gold and Silver Assays, cont.

pyrites. Weight of specimen, one pound two ounces. Assays gave:

Gold	distinct trace.
Silver	none.

PROVINCE OF BRITISH COLUMBIA.

Assays Nos. 69 *to* 112 *inc.*, 122, 123, *and* 136 *to* 159 *inc.*, *were conducted by Mr. E. B. Kenrick—Nos.* 65 *to* 67 *inc.*, 113, 120, 121, *and* 131 *to* 134 *inc.*, *by Mr. F. D. Adams, and Nos.* 68, 114 *to* 119 *inc.*, 124 *to* 130 *inc.*, 135, 160, *and* 161, *by Mr. R. A. A. Johnston.*

Province of British Columbia.

65.—From one of the Hepburn claims on Idaho Mountain, south-east side of Stump Lake, east side of the Nicola Valley stage road, from eight hundred to one thousand feet above the level of the lake, Nicola Valley. Examined for Senator W. E. Sanford.

It consisted of quartz, in parts honeycombed and more or less stained and coated with yellowish and brownish ochres, carrying small quantities of galena. Weight of specimen, nine and a-half pounds. It was found to contain:

Gold	0·759 of an ounce to the ton of 2,000 lbs.
Silver	406·574 ounces. " " "

66.—From Stump Lake, Nicola Valley.

It consisted of a coarse crystalline galena, through which was disseminated a rather small amount of copper-pyrites and a very small quantity of an indigo-blue sulphide, apparently resulting from the alteration of the copper-pyrites, and allied to covellite, as likewise a little quartz. It contained:

Gold	distinct trace.
Silver	20·339 ounces to the ton of 2,000 lbs.

Two samples of the galena of this specimen, carefully freed from all associated material, were assayed and found to contain:

The first—	Gold	none.
	Silver	32·900 ounces to the ton of 2,000 lbs.
The second—	Gold	none.
	Silver	31·135 ounces to the ton of 2,000 lbs.

The galena from different parts of the specimen is, therefore, not quite constant in its content of silver.

The copper-pyrites carefully freed from associated material, still containing, however, a small quantity of the above mentioned

Gold and Silver Assays, cont.

Province of British Columbia, cont.

indigo-blue mineral, which it was found impossible to exclude entirely, gave:

Gold................ distinct trace.
Silver.............. 1·600 ounce to the ton of 2,000 lbs.

67.—From the same locality as the last mentioned.

It consisted of a rather fine-grained mixture of galena, iron-pyrites and quartz. One portion of the specimen contained, intimately associated with the quartz, a considerable amount of tetrahedrite. The tetrahedrite, freed from associated minerals, still containing some quartz, however, was assayed and found to contain:

Gold................. 1·823 ounce to the ton of 2,000 lbs.
Silver................. 434·328 ounces " "

The amount of quartz in some of the material employed for assay was estimated and found to amount to 17·475 per cent. The quantities of the precious metals in the pure tetrahedrite would, therefore, be as follows:

Gold................. 2·209 ounces to the ton of 2,000 lbs.
Silver...............526·299 " " "

68.—Also, from Stump Lake, the precise locality was not stated.

It consisted of a white sub-translucent quartz, carrying a considerable quantity of galena: some portions of the specimen were stained with ferric hydrate, and in parts lightly coated with green carbonate of copper. Weight of specimen, two pounds five ounces. Assays showed it to contain:

Gold................ 6·096 ounces to the ton of 2,000 lbs.
Silver................ 90·650 " " "

69.—A specimen of ore, examined on a former occasion, from the property of what was formerly known as the Nicola Milling and Mining Company on Mineral Hill, south-east side of Stump Lake, west side of the Nicola Valley stage road, Nicola Valley, and which consisted of galena in association with tetrahedrite, small quantities of iron-pyrites, copper-pyrites, and a little bornite, in a gangue of quartz, the latter frequently very much honeycombed—the whole presenting a more or less weathered appearance, and for the most part coated with ferric hydrate, in parts with carbonate of lead, and here and there with a little green carbonate of copper, was found to contain:

Gold........... 0·729 of an ounce to the ton of 2,000 lbs.
Silver..........104·271 ounces " "

Gold and Silver Assays, cont.

Province of British Columbia, cont.

70.—This and the following specimen, also examined on a former occasion, is from the southern extremity of Stump Lake, Nicola Valley.

It consisted of a fine crystalline galena, associated with a little iron-pyrites, in a gangue of greyish-white translucent quartz. The metallic sulphides constituted, approximately, one-fourth, by weight, of the whole. Weight of specimen, three and a-half ounces. Assays showed it to contain :

Gold	0·729 of an ounce to the ton of 2,000 lbs.
Silver	15·094 ounces " "

71.—A somewhat coarse crystalline galena, in association with iron-pyrites, copper-pyrites, and a white translucent quartz; the latter constituted but a very small proportion of the whole. Weight of specimen, three and a-quarter ounces. Assays gave :

Gold	1·969 ounce to the ton of 2,000 lbs.
Silver	17·063 ounces " "

Of the following specimens, Nos. 72 to 112 inc., are from the District of Cariboo, and of these Nos. 72 to 109 inc., were collected by Mr. Amos Bowman.

72.—From Little Snow-shoe Creek, Cariboo District. T. Haywood's Discovery claim.

A white translucent quartz, with a little chlorite and a trifling amount of iron pyrites, with here and there a pseudomorph of limonite after pyrite. It was, in parts, thickly coated with ferric hydrate. Weight of specimen, eight ounces. It was found to contain :

Gold	0·408 of an ounce to the ton of 2,000 lbs.
Silver	0·058 " " "

73.—From the same locality as the last.

It consisted of quartz, in association with a little chlorite, it contained small quantities of iron-pyrites, and was in parts coated with ferric hydrate. Weight of specimen, one pound ten ounces. Assays gave :

Gold	distinct trace.
Silver	none.

74.—Also, from the same locality as No. 72.

A white sub-translucent quartz, with a little chlorite and a trifling amount of iron-pyrites; the whole was, for the most part,

coated with ferric hydrate. Weight of specimen, three and a-half ounces. It contained:

Gold and Silver Assays, cont.

British Columbia, cont.

Gold	very distinct trace.
Silver	none.

75.—From summit of Harvey Creek trail, Cariboo District.

A white sub-translucent to translucent quartz, in association with small quantities of a chloritic mineral: it was in parts coated with ferric hydrate. Weight of specimen, six and a-half ounces. Assays showed it to contain:

Gold	trace.
Silver	none.

76.—From Harvey Creek, below Falls, "Ironstone" ledge, Cariboo District.

Siderite, through which was disseminated small quantities of magnetic-pyrites and a little iron-pyrites. Weight of specimen, twelve ounces.

Assays gave:

Gold	very distinct trace.
Silver	none.

77.—From same locality as the last, about two hundred feet lower down the Creek.

An association of siderite and ankerite, through which was disseminated small quantities of iron-pyrites. The specimen was thickly coated with ferric hydrate. Weight of sample, three pounds eleven ounces.

It contained neither gold nor silver.

78.—From Duck Creek, Borland's ledge, Cariboo District.

A white translucent quartz, through which was disseminated a little iron-pyrites and a small amount of chlorite: it was in parts stained and coated with ferric hydrate. Weight of specimen, one pound fifteen ounces. It contained:

Gold	distinct trace.
Silver	none.

79.—From North Fork of Quesnel, near mouth of Spanish Creek, Cariboo District.

A white sub-translucent quartz, in parts thickly coated with

Gold and Silver Assays, cont.

Province of British Columbia, cont.

ferric hydrate. Weight of specimen, eight and a-half ounces. It was found to contain:

Gold	trace.
Silver	none.

80.—From Duck Creek, three hundred feet above the bridge, Cariboo District.

A white, translucent quartz carrying small quantities of galena, and a little iron-pyrites and zinc-blende: it was in parts coated with ferric hydrate. Weight of specimen, two pounds twelve ounces. It contained:

Gold	very distinct trace.
Silver	3·850 ounces to the ton of 2,000 lbs.

81.—From Cunningham Creek, near Sharp's, Cariboo District.

An association of ankerite and quartz, together with a little chlorite: it was in parts thickly coated with ferric hydrate. Weight of specimen, three and a-half ounces. Assays gave:

Gold	trace.
Silver	none.

82.—From Antler Creek, near Porter's cabin, Cariboo District.

It consisted of limestone with intermixed ankerite: the specimen was thickly coated with ferric hydrate. Weight of specimen, three pounds.

It contained neither gold nor silver.

83.—From Antler Creek, below site of old Antler town. Cariboo District.

A white sub-translucent quartz, in parts honeycombed, the cavities holding ferric hydrate; portions of the specimen were also thickly coated with this latter. Weight of specimen, two pounds. It was found to contain:

Gold	trace.
Silver	none.

84.—From same locality as the last, but from a different ledge.

A white translucent quartz, in parts slightly honeycombed, the cavities holding ferric hydrate. Weight of specimen, four ounces. Assays gave:

Gold	distinct trace.
Silver	none.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

85.—From Cunningham Creek, near head of Sharp's Ditch, Cariboo District.

It consisted of iron-pyrites in a gangue of quartz. Weight of specimen, one pound two ounces. Assays showed it to contain:

Gold	very distinct trace.
Silver	none.

86.—From Sugar Creek, cañon above Wiley's, upper ledge, Cariboo District.

A white sub-translucent quartz, carrying small quantities of iron-pyrites and a little copper-pyrites: it was for the most part stained with ferric hydrate. Weight of specimen, one pound nine ounces. It contained:

Gold	distinct trace.
Silver	none.

87.—From Sugar Creek, cañon above Wiley's, lower ledge.

A white sub-translucent quartz, in association with a small quantity of siderite: it was in parts coated with ferric hydrate. Weight of specimen, twelve ounces. Assays gave:

Gold	distinct trace.
Silver	[illegible]

88.—From Sugar Creek, cañon above Wiley's.

A white sub-translucent quartz, with here and there, a little siderite and a trifling amount of chlorite: it was in parts much honeycombed, the cavities holding ferric hydrate. Weight of specimen, one pound one ounce. It contained:

Gold	distinct trace.
Silver	none.

89.—From Sugar Creek, at Wiley's cabin.

A white sub-translucent to translucent quartz, with a little chlorite and a trifling amount of zinc-blende: it was for the most part thickly coated with ferric hydrate. Weight of specimen, one and a-quarter pound. Assays showed it to contain:

Gold	trace.
Silver	none.

90.—From Sugar Creek, opposite Walker's cabin.

A white sub-translucent quartz, containing small quantities of iron-pyrites: it was in parts thickly coated with ferric hydrate. Weight of specimen, eight ounces. It contained:

Gold	distinct trace.
Silver	none.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

91.—From Sugar Creek, branch half a mile south of junction.

A white sub-translucent quartz, carrying a little galena and iron-pyrites: it was for the most part stained with ferric hydrate. Weight of specimen, fourteen ounces. Assays gave:

Gold............ very distinct trace.
Silver............ 0·525 of an ounce to the ton of 2,000 lbs.

92.—From Mosquito Creek, Saunder's diggings, Cariboo Distrct.

An association of a white sub-translucent quartz and felspar, with here and there, a few flakes of silvery-white mica: it was for the most part, stained and coated with ferric hydrate. Weight of specimen, fourteen ounces. It was found to contain:

Gold .... trace.
Silver.. none.

93.—From Mosquito Creek, Flynn's diggins.

An association of galena and iron-pyrites, in parts coated with ferric hydrate: it was apparently free from gangue. Weight of specimen, eight ounces. It contained:

Gold........ .... 0·182 of an ounce to the ton of 2,000 lbs.
Silver............36·458 ounces " "

94.—From Mosquito Creek, also, from Flynn's diggins.

A white translucent quartz, with small quantities of siderite and chlorite. Weight of specimen, two pounds one ounce. Assays showed it to contain:

Gold.. trace.
Silver.. none.

95.—From "Lady of the Lake," Jack of Clubs Lake.

A white translucent quartz, in association with a small quantity of carbonaceous matter, carrying iron-pyrites: it was in parts stained with ferric hydrate. Weight of specimen, one pound ten ounces. It contained:

Gold................................ very distinct trace
Silver................................ none.

96.—From Grouse Creek, "Fountain Head" claim.

A white sub-translucent quartz, in association with a little chlorite: it was in parts much honeycombed, the cavities holding ferric hydrate. Weight of specimen, twelve and a-half ounces. It was found to contain:

Gold..................................... distinct trace.
Silver..................................... none.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

97.—From Grouse Creek, "Dufferin" ledge.

It consisted of iron-pyrites in a gangue of white sub-translucent quartz, with which was associated a small quantity of carbonaceous matter. Weight of specimen, two and a-half pounds. Assays showed it to contain:

Gold..................2·042 ounces to the ton of 2,000 lbs.
Silver.................0·292 of an ounce " "

98.—From Barkerville, "Proserpine" ledge at Wilkinson House.

A white sub-translucent quartz, with which was associated a small quantity of carbonaceous matter and a little siderite, carrying a small amount of iron-pyrites: it was for the most part stained with ferric hydrate. Weight of specimen, two pounds one ounce. Assays gave:

Gold.. trace.
Silver.. none.

99.—From Barkerville, "Proserpine" ledge at "Proserpine" shaft.

An association of iron-pyrites and galena in a gangue, consisting of quartz and chlorite. Weight of specimen, two pounds thirteen ounces. It was found to contain:

Gold .... 0·787 of an ounce to the ton of 2,000 lbs.
Silver ....20·738 ounces " "

100.—From Barkerville, "Home Rule" ledge.

An association of galena, iron-pyrites and limonite. Weight of of specimen, one pound. Assays showed it to contain:

Gold ....0·029 of an ounce to the ton of 2,000 lbs.
Silver............6·562 ounces " "

101.—From Barkerville, also, from the "Home Rule" ledge.

A coarse crystalline galena, with here and there a small quantity of white translucent quartz: it was, in parts, coated with ferric hydrate. Weight of specimen, one pound fourteen ounces. It contained:

Gold.... .... distinct trace.
Silver... .... 25·521 ounces to the ton of 2,000 lbs.

102.—From Barkerville, "Sergeant Lindsay" ledge.

A white sub-translucent quartz, for the most part stained and coated with ferric hydrate. Weight of specimen, two pounds eleven ounces. Assays gave:

Gold....................trace.
Silver...................1·808 ounce to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

103.—From Barkerville, "Stanley" ledge, opposite "Van Winkle" dump.

A white sub-translucent quartz, in association with a small quantity of a dark bluish-grey chloritic mineral: it contained in parts a little ferric hydrate. Weight of specimen, two pounds fifteen ounces. It was found to contain:

Gold	distinct trace.
Silver	none.

104.—From Barkerville, "Stanley" ledge, opposite "Van Winkle" Company's house.

This material was very similar in character to that of last mentioned specimen. Weight of sample, nine ounces. It contained:

Gold	trace.
Silver	none.

105.—From Burns Mountain, "Jacques" ledge.

A white translucent quartz, carrying small quantities of galena and iron-pyrites. Weight of specimen, one and a-quarter pound. Assays gave:

Gold	very distinct trace.
Silver	3·442 ounces to the ton of 2,000 lbs.

106.—From Burns Mountain, "Perkins" ledge.

A white translucent quartz, much honeycombed, carrying a little galena: it was for the most part stained with ferric hydrate. Weight of specimen, one pound. Assays showed it to contain:

Gold	2·625 ounces to the ton of 2,000 lbs.
Silver	3·033 " " "

107.—From Burns Mountain, also from "Perkins" ledge.

A coarse crystalline galena, with here and there a few specks of pyrite, in association with a small quantity of white translucent to transparent quartz: it was in parts coated with ferric hydrate. Weight of specimen, two pounds ten ounces. It was found to contain:

Gold	0·365 of an ounce to the ton of 2,000 lbs.
Silver	29·896 ounces " "

108.—From Chisholm Creek, near Stanley; lowest stringers.

A white, sub-translucent quartz with a little chlorite: it was

Gold and Silver Assays, cont.

Province of British Columbia, cont.

for the most part stained with ferric hydrate. Weight of specimen, eleven ounces. It contained:

Gold	distinct trace.
Silver	none.

109.—From Lightning Creek, "Sam Montgomery's" ledge.

A white, sub-translucent quartz with which was associated a little chlorite: it was more or less stained with ferric hydrate. Weight of specimen, one pound fifteen ounces. Assays gave:

Gold	distinct trace.
Silver	none.

110.—From the "Hixon Creek" Mine, Hixon Creek, Upper Fraser River. Taken from a depth of about 200 feet.

It consisted of an association of chlorite and iron-pyrites, with a little calcite. Weight of specimen, three and three-quarter ounces.

It contained neither gold nor silver.

111.—Another specimen from this mine was found to contain:

Gold	0·408 of an ounce to the ton of 2,000 lbs.
Silver	1·225 ounce " "

112.—From the "Dunlevy" ledge, Island Mountain.

It consisted of iron-pyrites in a gangue of quartz. Weight of specimen, two pounds. It was found to contain:

Gold	0·233 of an ounce to the ton of 2,000 lbs.
Silver	0·350 " " "

113.—From near Granite Creek, Similkameen River.

It consisted of an impure rudely banded limestone stained with ferric hydrate. Weight of specimen, thirteen and a-half ounces. Assays gave:

Gold	trace.
Silver	0·029 of an ounce to the ton of 2,000 lbs.

114.—From Otter-Tail, seven miles south-east of Otter-Tail Station, Canadian Pacific Railway, Rocky Mountains. This, and the following five specimens were examined for Mr. G. Pollock.

It consisted of galena, through which was disseminated a very large amount of ferric hydrate. Weight of specimen, two and a-half ounces.

It contained neither gold nor silver.

115.—From the vicinity of Otter-Tail Station, Canadian Pacific Railway, Rocky Mountains.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

The specimen, which consisted of purple copper ore, weighed two and three-quarter ounces. Assays showed it to contain:

Gold............. none.
Silver.............. 19·687 ounces to the ton of 2,000 lbs.

116.—From the same locality as the last mentioned.

It consisted of a fine crystalline galena in association with small quantities of iron-pyrites and dolomite. Weight of specimen, one ounce. It was found to contain:

Gold.... .... none.
Silver................. 4·739 ounces to the ton of 2,000 lbs.

117.—This, and the two following specimens are from within two miles west of Field Station, on the line of the Canadian Pacific Railway, Kicking Horse (Hector) Pass, Rocky Mountains.

A white sub-translucent quartz, more or less coated with ferric hydrate. Weight of specimen, nine ounces.

It contained neither gold nor silver.

118.—A white translucent quartz thickly coated with ferric hydrate. Weight of specimen, eight ounces.

It contained neither gold nor silver.

119.—A white sub-translucent quartz, carrying copper-pyrites: it was for the most part coated with ferric hydrate, and here and there with a little green carbonate of copper. Weight of specimen, five ounces.

It contained neither gold nor silver.

120.—From mountain near Hope, Fraser River.

It consisted of magnetic-pyrites and a little iron-pyrites, together with a small quantity of a dark siliceous rock. Weight of specimen, twelve ounces. Assays showed it to contain:

Gold........... distinct trace.
Silver........... 0·263 of an ounce to the ton of 2,000 lbs.

121.—Described as casing rock of preceding specimen.

A rather fine-grained, greyish, banded silicious rock, containing a good deal of calcite, and here and there a few small grains of iron-pyrites. Weight of specimen, five and a-half ounces. Assays gave:

Gold........... trace.
Silver........... 0·116 of an ounce to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

122.—From Kamloops Lake, near Cherry Creek.

An association of quartz, calcite, and serpentine, with a little specular iron and a few specks of copper-pyrites. Weight of specimen, fourteen ounces. It was found to contain:

Gold............ trace.
Silver........... 0·350 of an ounce to the ton of 2,000 lbs.

123.—From the North Thompson, above Clearwater River.

A white opaque quartz carrying small quantities of a dark leaden colored mineral (which was not identified as the abstraction of a sufficient amount of material to enable this to be done, would have injured the specimen for assay), and a little limonite. Weight of specimen, four and three-quarter ounces. It contained:

Gold...... .... 4·375 ounces to the ton of 2,000 lbs.
Silver................ 21·350 " "

124.—From the head of Waterton River, Rocky Mountains. Examined for Mr. G. Cusick.

An association of a white sub-translucent quartz, chloritic schist, and a little dolomite, carrying galena, magnetic-pyrites and a small amount of copper-pyrites: it was, in parts, coated with ferric hydrate, and here and there, stained with green carbonate of copper. Weight of specimen, eight ounces. Assays gave:

Gold................ trace.
Silver................ 1·575 ounce to the ton of 2,000 lbs.

125—From a vein on the west side of the Upper Kootenay River, between the mouth of Finlay Creek and the upper crossing. This, and the five following specimens were examined for Mr. A. B. Grohman.

A milky white quartz in association with a little dolomite and greenish-grey chloritic schist: the whole was more or less coated with ferric hydrate. Weight of specimen, eleven ounces. It was found to contain:

Gold.. trace.
Silver.............. .... none.

126.—From a lead on the south bank of Elk River, between the bridge and lower ford.

A white opaque quartz in association with small quantities of a bright green chloritic mineral: it contained, in parts, a little hematite and ferric hydrate. Weight of specimen, fifteen ounces.

It contained neither gold nor silver.

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Gold and Silver Assays, cont.

Province of British Columbia, cont.

127.—From a lead on the south slopes of Cinnabar Mountain, Upper Kootenay River, above Canal flat.

An association of dolomite, red and white calcite, and crystalline quartz: it was, in parts, stained with ferric hydrate. Weight of specimen, six and a-half ounces.

It contained neither gold nor silver.

128.—From a lead on the south bank of the Kootenay River, about two miles above the upper crossing.

A white opaque, and greyish-white translucent quartz: in parts stained with ferric hydrate. Weight of specimen, seven and a-half ounces,

It contained neither gold nor silver.

129.—From near the outlet of Kootenay Lake.

Consisted, apparently, exclusively of bornite, through which was disseminated a few grains of colorless, transparent quartz. Weight of specimen, three-quarters of an ounce. It was found, on assay, to contain:

Gold .... none.
Silver.............. 119·218 ounces to the ton of 2,000 lbs.

130.—From the south-east quarter of lot eleven, township fifteen, New Westminster district.

A white translucent quartz, in association with chloritic schist: it contained a trifling amount of copper-pyrites, was in parts coated with ferric hydrate, and here and there, stained with green carbonate of copper. Weight of specimen, one pound five ounces. Assays gave:

Gold.. trace.
Silver.. none.

131.—From the vicinity of Illecillewaet Station, on the line of the Canadian Pacific Railway.

A very fine-grained bluish-grey siliceous rock, through which was disseminated a small quantity of magnetic-pyrites in very minute grains. Weight of specimen, one ounce.

It contained neither gold nor silver.

132—This, and the three following specimens are from the Illecillewaet district. They were examined for Mr. W. McGirr.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

A coarsely crystalline galena. Weight of specimen, two ounces. On assay was found to contain:

Gold................ mere trace.
Silver............... 64·859 ounces to the ton of 2,000 lbs.

133.—A translucent quartz, carrying iron-pyrites: it was more or less stained with ferric hydrate. Weight of specimen, one and a-half ounces.

It contained neither gold nor silver.

134.—Consisted of zinc-blende, together with a few specks of copper-pyrites, in a gangue of greyish translucent quartz. Weight of specimen, ten and a-half ounces. Assays gave:

Gold............ distinct trace.
Silver........... 0·262 of an ounce to the ton of 2,000 lbs.

135.—A white translucent quartz, carrying a good deal of copper-pyrites. Weight of specimen, one pound five ounces. It was found to contain:

Gold................ trace.
Silver............... 2·946 ounces to the ton of 2,000 lbs.

136.—This, and the two following specimens are from within about a mile of the Illecillewaet Station, on the line of the Canadian Pacific Railway.

A moderately coarse crystalline galena, in a gangue of translucent quartz. Weight of specimen, one pound two ounces. It contained.

Gold.............. none.
Silver............... 24·208 ounces to the ton of 2,000 lbs.

137.—An association of zinc-blende, galena, magnetic-pyrites and iron-pyrites, in a quartzose gangue. Weight of specimen, twelve and a-quarter ounces. Assays gave:

Gold................. trace.
Silver................ 1·823 ounce to the ton of 2,000 lbs.

138.—Consisted of magnetic pyrites. Weight of specimen, one ounce. It was found to contain:

Gold.. trace.
Silver.. none.

139.—From the border of a lake in the vicinity of the Illecillewaet Station, on the line of the Canadian Pacific Railway. About two miles from the track, south side.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

A magnetic sand. Weight of specimen, one pound five and a-half ounces. It was found, on assay, to contain:

Gold.................................... trace.
Silver.................................... none.

140.—From four miles east of the Illecillewaet Station, north side of the line of the Canadian Pacific Railway.

It consisted of magnetite, in a gangue of quartz and chlorite. Weight of specimen, six and a-quarter ounces.

It contained neither gold nor silver.

141.—This, and the following specimen are from about fifteen miles west of summit of the Selkirk Range, and three miles north of the line of the Canadian Pacific Railway.

It consisted of quartz, carrying a little galena. Weight of specimen, eleven ounces. It contained:

Gold.................. trace.
Silver.................. 6·475 ounces to the ton of 2,000 lbs.

142.—Consisted of galena, magnetic-pyrites, and iron-pyrites, with a little quartz. Weight of specimen, fourteen and a-quarter ounces. Assays gave:

Gold.................. none.
Silver..................10·937 ounces to the ton of 2,000 lbs.

143.—From the Illecillewaet River.

An association of a coarsely crystalline galena, zinc-blende, and a little iron-pyrites, in a gangue consisting of translucent to transparent quartz, and chlorite. The metallic sulphides constituted, approximately, sixty-seven per cent., by weight, of the whole. Weight of specimen, six and a-quarter ounces. It was found to contain:

Gold.................. trace.
Silver.................. 45·208 ounces to the ton of 2,000 lbs.

144.—Same locality as the last.

A modeartely coarse, to coarse crystalline galena, with a little zinc-blende, and a small quantity of iron-pyrites, in a gangue composed of translucent quartz, together with a little chlorite and calcite; it was, in parts, stained and coated with ferric hydrate. The metallic sulphides constituted but a very small proportion of the whole. Weight of specimen, about thirteen pounds. Assays showed it to contain:

Gold.................. trace.
Silver.................. 9·683 ounces to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

145.—From the Illecillewaet River, Selkirk Range, north side of the valley. Received from Mr. G. R. Wright.

An association of iron-pyrites and galena, in a gangue of white, translucent quartz. Weight of specimen, three ounces. Assays gave:

Gold............... none.
Silver.............. 247·917 ounces to the ton of 2,000 lbs.

146.—From the Illecillewaet River, Selkirk Range, south side of the valley. Received from Mr. G. R. Wright.

An association of galena, tetrahedrite and a little iron-pyrites, with some quartz. Weight of specimen, one and a-quarter ounce. It contained:

Gold............... none.
Silver.............. 484·167 ounces to the ton of 2,000 lbs.

147.—A sample of material, from the same opening as the last, as dressed for shipment, and consisting, apart from a very small quantity of iron-pyrites, almost exclusively of tetrahedrite, was found to contain:

Gold............... distinct trace.
Silver.............. 816·667 ounces to the ton of 2,000 lbs.

148.—This, and the following eight specimens are from the Illecillewaet district.

A white opaque quartz, carrying a little tetrahedrite and a trifling amount of copper-pyrites: it was in parts coated with ferric hydrate; also with a little green and blue carbonate of copper. Weight of specimen, one ounce. Assays gave:

Gold............... trace.
Silver.............. 248·646 ounces to the ton of 2,000 lbs.

149.—A moderately coarse crystalline galena, in association with quartz and a little hydrated peroxide of iron. Weight of specimen, two ounces. It contained:

Gold............... none.
Silver.............. 47·396 ounces to the ton of 2,000 lbs.

150.—An opaque quartz, carrying small quantities of a moderately coarse crystalline galena and a trifling amount of iron-pyrites: it also contained, in parts, a little hydrated peroxide of iron. Weight of specimen, two ounces. It was found to contain:

Gold............... trace.
Silver.............. 5·833 ounces to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

151.—A white opaque quartz, carrying galena, tetrahedrite, zinc-blende and a little iron-pyrites. Weight of specimen, one and a-half ounces. Assays showed it to contain:

Gold................ trace.
Silver.... .... 127·604 ounces to the ton of 2,000 lbs.

152.—A moderately coarse crystalline galena. Weight of specimen, two ounces. It was found, on assay, to contain:

Gold................ trace.
Silver............... 57·604 ounces to the ton of 2,000 lbs.

153.—Quartz carrying small quantities of galena and tetrahedrite: it was, in parts, coated with a little ferric hydrate and green carbonate of copper. Weight of specimen, four ounces. It contained:

Gold............ none.
Silver........ ... 0·729 of an ounce to the ton of 2,000 lbs.

154.—An association of moderately coarse crystalline galena and translucent quartz. Weight of specimen, three and three-quarter ounces. Assays gave:

Gold................ distinct trace.
Silver.............. 54·687 ounces to the ton of 2,000 lbs.

155.—A coarsely crystalline galena, in association with a small proportion of translucent quartz: it was in parts stained and coated with ferric hydrate. Weight of specimen, not quite four ounces. It was found to contain:

Gold............... trace.
Silver.............. 67·813 ounces to the ton of 2,000 lbs.

156.—An association of moderately coarse crystalline galena and tetrahedrite, together with small quantities of white, opaque, quartz. Weight of specimen, one and a-half ounce. Assays gave:

Gold.......... ..... none.
Silver.............. 180·104 ounces to the ton of 2,000 lbs.

157.—From the "Kitawat" ledge, Kitawat, Gardner Inlet. Received from Mr. W. Downie.

It consisted of a white translucent quartz: carrying small quantities of copper-pyrites, zinc-blende, and galena. Weight of specimen, four pounds seven ounces. Assays showed it to contain:

Gold............ .... distinct trace.
Silver............... 4·433 ounces to the ton of 2,000 lbs.

158.—From Discovery Passage, Vancouver Island. Collected by Dr. G. M. Dawson. Gold and Silver Assays, cont.

A white sub-translucent quartz, carrying a little copper-pyrites. Weight of specimen, one pound ten ounces. Assays gave: Province of British Columbia, cont.

Gold............ very distinct trace.
Silver.......... 0·175 of an ounce to the ton of 2,000 lbs.

159.—From the Malaspina copper-mine, north-east side of Texada Island. Collected by Dr. G. M. Dawson.

It consisted of an association of copper-pyrites and iron-pyrites, together with a little magnetite, in a gangue composed of calcite, small quantities of a dark green chlorite, and a little quartz. The metallic sulphides constituted, approximately, fifty-five per cent., by weight, of the whole. Weight of specimen, five pounds five and a-quarter ounces. It was found to contain:

Gold............... trace.
Silver.............. 10·209 ounces to the ton of 2,000 lbs.

160.—From Harriet Harbor, Skincuttle Inlet, Queen Charlotte Islands.

The material here in question is referred to in the Report of Progress for 1878-79, Part B, p. 52, where it is described by Dr. G. M. Dawson as "a material which appears to be a felspathic ash rock containing a large proportion of calcareous matter. It is grey in color, speckled by the mixture of light and dark fragments, and shot through with iron-pyrites in small concretions and veins." Weight of specimen, one pound six ounces.

It contained neither gold nor silver.

161.—From the vicinity of the iron mine, north of Gillies Bay, Texada Island. Collected by Dr. G. M. Dawson and referred to by him in the Annual Report, vol ii., part B, p. 35.

It consisted of a granitoid rock, through which was disseminated a little iron-pyrites. Weight of specimen, one pound six ounces.

It contained neither gold nor silver.

MISCELLANEOUS EXAMINATIONS.

1.—Iron-pyrites.—From lot five, range four of the township of Darling, Lanark county, Ontario. Examined for Mr. H. Torrance. Iron pyrites from Darling, Lanark county, Ont.

Mr. F. D. Adams has made an analysis of a sample of ore from this locality, and with the following results:—

Sulphur		49·228
Arsenic		0·174
Iron (calculated)		43·074
Insoluble matter.......6·353; Carbonate of lime.......1·946	gangue	8·299
Water, hygroscopic		0·141
		100·916

Other samples from this deposit have recently been assayed by Mr. R. A. A. Johnston for gold and silver—the results were negative.

Chromic-iron-ore from Thetford, Megantic county, P.Q.

2.—Chrome-iron-ore.—From lot seventeen, range four of Thetford, Megantic county, Province of Quebec. Examined for Dr. James Reed.

The specimen consisted of chromite in intimate association with massive and fibrous serpentine. Mr. E. B. Kenrick found it to contain:—

Chromic oxide........................ 35·46 per cent.

Limestone from Agassiz Station, B.C.

3.—Limestone.—From near Agassiz Station, on the line of the Canadian Pacific Railway, British Columbia.

Three specimens of material from this deposit have been examined by Mr. F. D. Adams. The first, when treated with dilute hydrochloric acid left a considerable amount of a gritty insoluble residue. When burnt, the resultant product slaked readily, affording a fairly white lime of good quality. The second, when treated with acid, left a good deal of insoluble residue. The burnt material slaked readily, yielding a lime of very pronounced color, due to the presence of small quantities of iron-pyrites in the original stone. The lime could be used for all purposes where color was no object. The third, contained a very large amount of insoluble matter amounting, approximately, to rather more than fifty per cent. of the rock. The burnt material slaked but imperfectly. This stone is unsuited for the preparation of a lime.

Tin ore, reported finding of.

4.—Tin ore, reported finding of.—The material here referred to was brought to the Survey by Dr. J. Latimer, who stated that it had been taken from an opening on the sixth lot of the eleventh range of Whitton, Compton county, Province of Quebec.

It weighed eight pounds fourteen and a-half ounces; the material composing it was for the most part in the form of fragments, the balance was in the form of coarse sand and dust, this constituted, however, but a comparatively small proportion, by weight, of the whole.

The "bulk of the material" consisted of a greyish-white to white sub-translucent quartz, and a dark grey rock, together with a little chlorite, and felspar, all of which were (with an occasional exception in favor of the two former—a few of the fragments consisting almost exclusively of the one or the other) in more or less intimate association. All the fragments here referred to contained more or less iron-pyrites, most frequently well crystallized in cubes, and were to a greater or less extent stained or coated with ferric hydrate. Intermixed with the foregoing were two fragments of arsenical pyrites (one consisting almost exclusively of arsenopyrite, the other of an association of arsenopyrite with white translucent quartz), a fragment of intermixed magnetite and specular iron, and numerous fragments of tin stone, one of which weighed not less than nine and a-half ounces. The tin stone, which was in parts well crystallized, was remarkably free from gangue, containing but a trifling amount of rock matter consisting, essentially, of white translucent to opaque quartz. On two of the fragments of tin stone were observed, what apparently consisted of, the remains of imperfectly removed labels. In no instance could, even so much as a speck of tin stone be detected in any one single fragment of some three hundred fragments which went to make up what has been above described as "the bulk of the material," and which it was left to be inferred constituted the original gangue of the tin stone. The locality whence the foregoing was stated to have been obtained, was subsequently visited by Dr. R. W. Ells, of this Survey, who collected and forwarded me a sample of material, weighing some forty pounds, from the same opening. This was examined by Mr. F. D. Adams, who found the rock matter composing it to be very similar in character to that of the sample received from Dr. Latimer, it contained, however, much less iron-pyrites, no arsenical-pyrites, nor so much as a speck of tin stone.

The material of the first mentioned sample was, after separation of the cassiterite, submitted to assay, and found to contain a trace of gold but no silver.

5.—Terra cotta.—A clay well suited for the manufacture of this ware, occurs on the east-half of lot two, range seven, of the township of Nassagaweya, Halton county, Ontario. When burnt, it assumes a very pleasing color, one that would more especially recommend it for works of an architectural character, such as bas-reliefs, friezes, and the like. Terra cotta, clay suitable for manufacture of. From Nassagaweya Halton county, Ont.

6.—Zinc-blende.—What may prove to be an important deposit, the Zinc-blende.

extent of which has not, however, as yet been ascertained, of this ore occurs on the tenth lot of the fourth range of Calumet, Pontiac county, Province of Quebec. It consists of a more or less intimate association of zinc-blende and galena, together with small quantities of iron-pyrites. The proportion of the two latter, more especially the galena, to the former, varied greatly in different specimens. A fair average of numerous samples of this material was submitted to assay, and found to contain 11·666 ounces of silver to the ton of 2,000 lbs., together with traces of gold.

Magnetite pseudomorph after pyrite.

7.—Magnetite crystals pseudomorph after pyrite. When examining the sample of iron ore from the vicinity of Kinnear's Mills, referred to on a preceding page under Iron Ores—No. 2, Mr. E. B. Kenrick observed, imbedded in the same, some small crystals which were in the form of cubes with faces striated parallel to the edges of the pyritohedron. They were black in color and showed a high metallic lustre and brilliant faces. The best crystals had cubic edges, measuring one millimetre or less in length. The crystals were very magnetic, being easily picked up with a magnet. Streak brown. Soluble in aqua regia with very slight residue. Gave off water in closed tube. A crystal weighing ·0083 gram lost on ignition ·0008 gram, or 8·6 per cent. of water. This crystal was magnetic after ignition, and remained unchanged in appearance. It would appear that the crystals are pseudomorphs after iron-pyrites in an intermediate stage between limonite and magnetite.

Stibnite from Foster's Bar, Fraser River, B.C.

8.—Stibnite. This mineral has been found near Foster's Bar, about twenty-three miles from Lytton, Fraser River, British Columbia. The sample received, and which weighed rather less than four pounds, was remarkably pure, being almost entirely free from gangue. Assays showed it to contain a trace of gold, and 2·187 ounces of silver to the ton of 2,000 lbs.

Rose-colored muscovite from Villeneuve, Ottawa county, P.Q.

9.—Rose-colored muscovite.—Amongst some of the interesting specimens recently collected by Mr. C. W. Willimott was one—found by him on lot thirty-one of the first range of Villeneuve, Ottawa county, P. Que.—consisting of a rose-red colored mica and pale-green muscovite, in a matrix composed of albite with a little white translucent quartz. The first mentioned, when heated before the blowpipe, was found to be difficulty fusible and to give a slight yet distinct lithia re-action. It apparently, closely resembles, if indeed it is not identical with, the rose-red colored muscovite of Goshen, Mass., examined by Prof. J. W. Mallet.

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(NEW SERIES.)

ABBREVIATIONS.

Al.	District of Alberta.	N.W.T.	North-West Territory.
B.C.	British Columbia.	O.	Province of Ontario.
Ma.	Manitoba.	Q.	Province of Quebec.
N.B.	New Brunswick.	Sk.	District of Saskatchewan.
N.S.	Nova Scotia.	V.Is.	Vancouver Island.